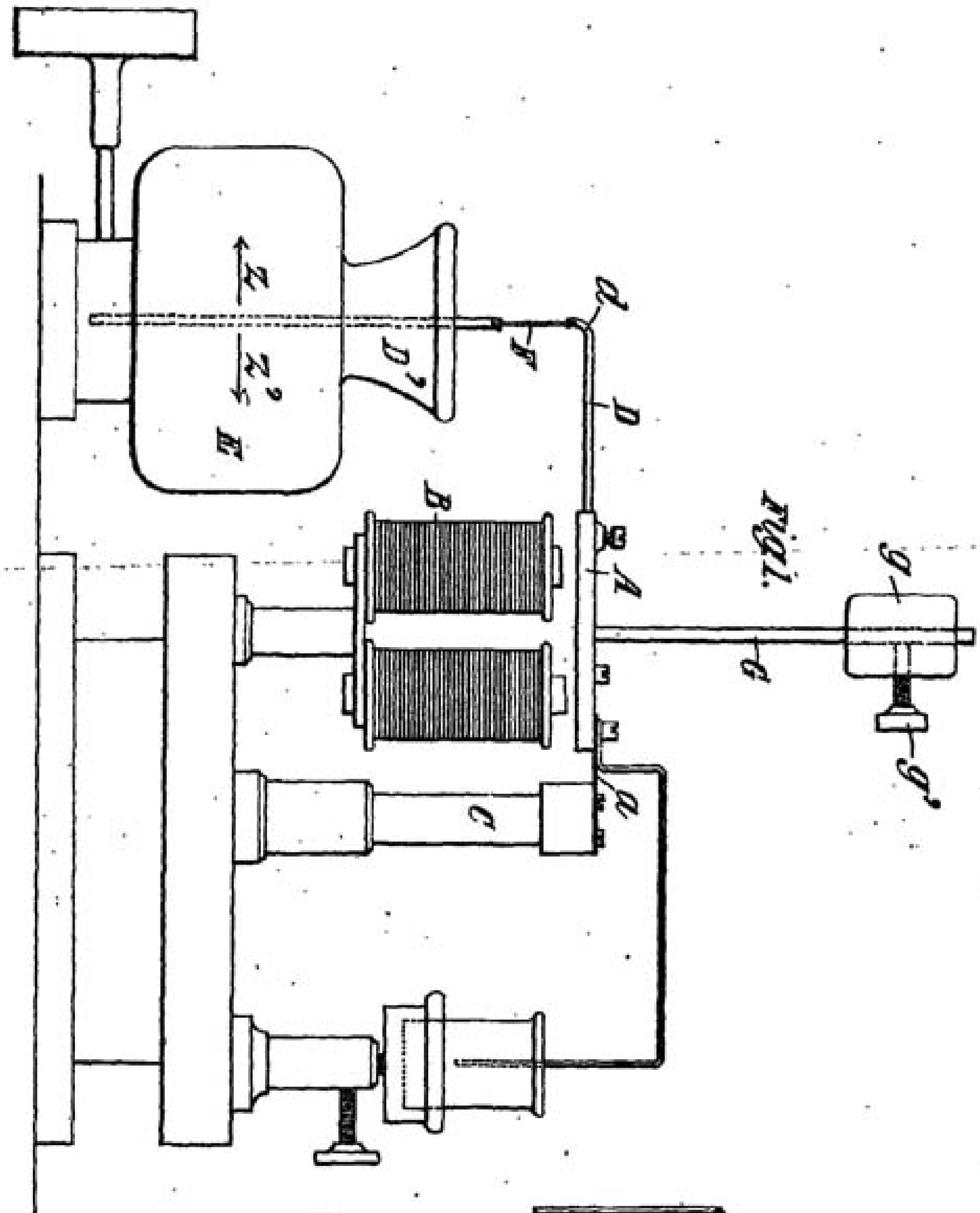

Fig.1.

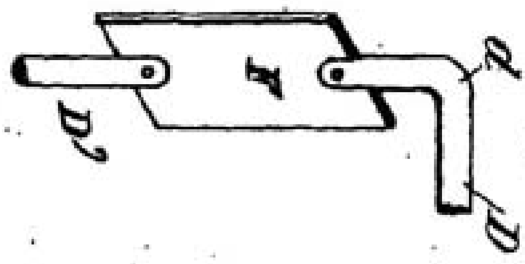

Fig.2.

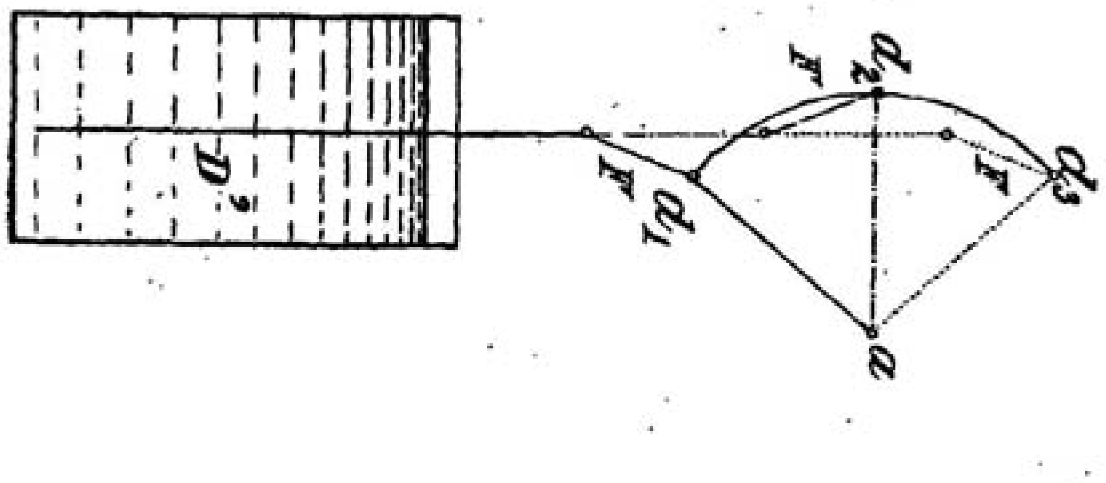

Fig.3.

[This Drawing is a reproduction of the Original on a reduced scale]

Malby&Sons, Photo-Litho.

by two sheets of paraffined paper between which the insulating substance is also interposed and a second layer is then formed, and so on; the coil being completed by the application of 4 or 5 sheets of paraffined paper.

These coils are then submitted to an immersion of twenty four hours in a hot solution of paraffin in petroleum in variable proportions.

They are then cooled in this bath from which they are withdrawn for fixing upon the tube. They are then suitably connected so as to form the secondary circuit.

When the whole of the primary and secondary systems has been mounted and fixed in the receptacle this latter is filled with a solution of paraffin in petroleum, in such a manner as to completely immerse the primary and secondary coils, and this solution is maintained in a heated condition for several hours.

The secondary wires issue through tubes from this bath of paraffined petroleum which sets into a jelly upon cooling. These tubes may be of thick crystal or of any other suitable insulating substance. Terminals which serve to collect the secondary current are mounted at the ends of these tubes; they may be of any suitable kind.

In powerful apparatus, these tubes are made up of two concentric tubes closed one upon the other at each extremity. The space between is filled with insulating medium in a liquid or pasty condition, whilst through the central portion which is left free passes the secondary wire.

When the apparatus is less powerful, and the ordinary Ruhmkorff winding can be readily employed, that is to say with the secondary circuit merely insulated with gum lac the interposition of a tube similar to that above described, but of larger dimensions, between the primary and secondary circuits, permits, whilst avoiding the secondary derivations which are produced in the forms of emanations into the metallic mass of the primary circuit, of increasing in considerable proportions the output of the secondary coils.

After a great number of experiments we have found that it is essentially a compact insulation which it is necessary to effect in order to avoid the secondary derivation which have hitherto been inevitable with currents of very high pressure. In fact, crystal which has about 1500 times the resistance of our insulating medium, may be traversed with extreme facility in thicknesses which are from four to five times those at which our insulating medium possesses absolute resistance.

The mixture which we employ is however specifically of smaller resistance than crystal after a certain duration of electrisation, but it is in a semiliquid gelatinous state which, unlike even the densest crystal, does not present numerous pores through which sparks so readily force a passage.

The liquid insulation which is readily obtained by immersing the apparatus which it is desired to insulate in a bath of oil of any kind, whether mineral or not, ceases to give good results with very high pressures and even with quite ordinary pressures. It does not, it is true, possess the disadvantage of porosity, but it has another which is equally prejudicial; the molecules which constitute the liquid become positively and negatively electrised in the vicinity of the extreme secondary poles, and owing to the extreme mobility of the insulating medium these molecules violently attract each other and re-constitute, in the form of a rapid quivering of the liquid, the two electricities. If the frequency of the inducing current increases, the shock of the molecules becomes sufficiently considerable to produce projections of the liquid, if the frequency still increases the quivering becomes more confined, more rapid, but less visible, becoming quite invisible with extremely high frequencies, but being always injurious.

The trembler or interruptor which alternately establishes and interrupts the current in the primary circuit is composed of a copper or aluminium balance inserted in a small mass of copper in which it is able to slide and fixed in the desired position by a set screw, a plunging contact of iron or platinum is provided which establishes contact with the mercury contained in a vessel. At the other extremity of the balance is the iron armature which is intended to be alternately attracted by the electro-magnet.

The point successively enters and leaves the mercury bath as a consequence of the successive oscillatory movements of the beam which is supported by the straight spring, one end of which is inserted in the mass and the other in the supporting foot.

We provide a spring fixed upon the beam and furnished with a small plate of platinum upon its upper portion. A screw having a platinum point serves to conduct the current to the point of contact with the platinum spring.

This screw may, at the same time as it is raised or lowered by un-screwing or screwing it in its support, be laterally displaced and make contact wth the platinised spring at any point upon this latter, thus either approaching or receding from the centre of the beam.

The electro-magnet may be either raised or lowered by means of a milled knob actuating a pinion gearing with the rack.

The mercury cup may also be raised or lowered by means of a similar arrangement.

The oscillation of the beam takes place in the following manner: The current of a battery cell, for example enters through the screw of the trembler which conducts the current to the platinised spring; the current passing through the beam, the mass and the spring passes out from the foot to the electro-magnet which it leaves and proceeds to the second pole of the battery cell in question. Under the conditions just described, the current circulates and the electro-magnet attracts its armature the beam having been depressed towards the right hand by this movement breaks the contact which existed between the screw and the spring, the current no longer enters the electro-magnet which ceases to attract its armature so that the original conduction of things exists, thereupon the screw again makes contact with the spring, and so on in succession.

Where radiography is concerned it is of the highest importance that the frequency of the currents should be variable; the radiography tubes only give their maximum of X rays with a predetermined frequency, which explains the very poor results given by first class tubes and coils having a fixed frequency, because the current interruptions of these latter are not suitably proportioned to the tubes experimented with.

It is thus of the greatest importance to be able to cause this frequency to vary whilst operations are in progress, and this is obtained with the greatest ease by lateral displacement of the screw. The more this screw is pushed in the proper direction, the greater becomes the rapidity of the trembler. The spring becoming less flexible in proportion as its foot is approached, no longer permits the screw to remain long in contact and this latter always rests slightly upon it, from which results an acceleration of the movements of the beam.

The intensity of the attraction of the armature also exerts considerable influence upon the rapidity of the interruptions; it should neither be too abrupt nor too weak in order that the rupture of the primary current may take place normally at the contact. In order to readily obtain the necessary magnetic adjustment, the electro-magnet is raised and lowered as above indicated.

The principal current which serves to excite the primary circuit of the coil enters through the foot, passes through the spring, the beam and the plunging contact then enters the mercury bath, whence it passes into the primary coil through the supporting foot of the mercury cup.

The mercury is covered by a stratum of ethylic alcohol whilst the apparatus is in action.

As in Ruhmkorff's coil, a condenser is employed, the armatures of which are respectively in communication with the two electrodes between which passes the spark on the rupture of the primary circuit, in order to absorb a portion of the extra current, and to render shorter the cessation of the current in the inducing circuit.

It has been observed that the period of rupture should be shorter than the period during which the current is closed in the primary circuit, and this in a manner which is variable with the intensity of the current employed, the self induction of the primary circuit and so forth.

The best conditions of duration and rupture of contact may be obtained by adjusting the height of the mercury cup by means of the knob actuating the rack which supports the cup.

Dated this 29th day of January 1898.

HASELTINE, LAKE & Co.,
45, Southampton Buildings, London, W.C.,
Agents for the Applicants.

COMPLETE SPECIFICATION.

An Improved Electrical Transformer for Currents of High Potential and Variable Frequency.

We, Alfred Wydts and Octave Maximilien Rochefort, both of 46, Boulevard Haussmann, Paris, in the Republic of France, Engineers, do hereby declare the nature of this invention, and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to a novel electrical induction transformer of the Ruhmkorff type, especially applicable to the production of Crookes's radiations, to obtaining currents of high frequency, to ignition by the induction spark, to the operation of commercial medical ozonaters and so forth.

In order that our invention may be readily and clearly understood we have represented the same in the accompanying drawing.

The primary circuit is formed by a relatively large and short wire A, making a small number of turns around a central core B of annealed iron wires which are insulated one from the other, in order to obviate, to a certain extent, the production of Foucault's currents and at the same time diminish "hysteresis."

This primary coil is enclosed in a tube C of glass, crystal or any other suitable insulating substance and held in a central position by means of two washers D D of fibre or other insulating material, in such a manner that between the wires and the internal wall of the tube a free space E is left into which is run an insulating substance.

The glass tube C is itself supported by brackets F suitably shaped for its reception, or in any other appropriate manner, at the centre of a vessel L composed of an insulating substance such as glass, celluloid, porcelain or the like, which is subsequently filled with the insulating substance.

Upon the tube C is arranged the secondary circuit composed in the following manner:

A certain number (according to the power of the apparatus) of elementary coils G G . . . constructed in the manner which is hereinafter explained, is arranged upon the glass tube C; the coils are all connected in series and the two free end wires H, H are connected to the secondary terminals of the apparatus, of which they constitute the two poles.

The secondary coils G are formed in the following manner;

Upon a wooden mandrel, which is slightly conical in form so as to facilitate the dismounting of the coils, and which is mounted upon a disc or wheel which, in turning, travels at the same time in the direction of its length, are stuck 5 or 6 sheets of paper which have been carefully paraffined and cut into strips of the same width as the elementary coils. These sheets of paper are superposed so as to form a paper tube of considerable strength; it will however be understood that this core may also be formed of cardboard, wood or the like without affecting the result obtained.

When this core has been formed, the coiling of the second wire may be commenced, care being taken to leave between each turn a slight interval which is afterwards filled up by the insulating substance. This first layer I is then covered by two sheets of paraffined paper between which the insulating substance is also interposed, and a second layer K is then formed, and so on; the coil being completed by the application of 4 or 5 sheets of paraffined paper.

These coils are then submitted to an immersion for twenty four hours in a hot solution of paraffine in petroleum in variable proportions.

They are then cooled in this bath from which they are withdrawn for fixing upon the tube. They are then suitably connected so as to form the secondary circuit.

When the whole of the primary and secondary systems has been mounted and fixed in the receptacle L, this latter is filled with a solution of paraffine in petroleum, in such a manner as to completely immerse the primary and secondary coils, and this solution is maintained in a heated condition for several hours.

The secondary wires issue through tubes M M from this bath of paraffined petroleum which sets into a jelly upon cooling. These tubes may be of thick crystal or of any other suitable insulating substance. Terminals which serve to collect the secondary current are mounted at the ends of these tubes; they may be of any suitable kind.

In powerful apparatus, these tubes are made up of two concentric tubes P (Figure 2) closed one upon the other at each extremity. The space O between is filled with insulating medium in a liquid or pasty condition, whilst through the central portion which is left free passes the secondary wire Q R.

When the apparatus is less powerful, and the ordinary Ruhmkorff winding can be readily employed, that is to say with the secondary circuit merely insulated with gum lac the interposition of a tube similar to that shewn in Figure 2, but of larger dimensions, between the primary and secondary circuits permits, whilst avoiding the secondary derivations which are produced in the forms of emanations into the metallic mass of the primary circuit, of increasing in considerable proportions the output of the secondary coils.

After a great number of experiments we have found that it is essentially a compact insulation which it is necessary to effect in order to avoid the secondary derivation which have hitherto been inevitable with currents of very high pressure in fact, crystal which has about 1500 times the resistance of our insulating medium, may be traversed with extreme facility in thicknesses which are from four to five times those at which our insulating medium possesses absolute resistance.

The mixture which we employ is however specifically of smaller resistance than crystal after a certain duration of electrisation, but it is in a semiliquid gelatinous state which, unlike even the densest crystal, does not present numerous pores through which sparks so readily force a passage.

The proportions that we employ in order to obtain a good insulating mixture consists in utilising three parts of paraffine to one of petroleum.

The liquid insulation which is readily obtained by immersing the apparatus which it is desired to insulate in a bath of oil of any kind, whether mineral or not, ceases to give good results with very high pressures and even with quite ordinary pressures. It does not, it is true, possess the disadvantage of porosity, but it has another which is equally prejudicial; the molecules which constitute the liquid become positively and negatively electrised in the vicinity of the extreme secondary poles, and owing to the extreme mobility of the insulating medium, these molecules violently attract each other and re-constitute, in the form of a rapid quivering of the liquid, the two electricities. If the frequency of the inducing current increases, the shock of the molecules becomes sufficiently considerable to produce projections of the liquid, if the frequency still increases the quivering becomes more confined more rapid, but less visible, becoming quite invisible with extremely high frequencies, but being always injurious.

The trembler or interruptor which alternately establishes and interrupts the current in the primary circuit is composed of a copper or aluminium balance A^1 (Figure 3) inserted in a small mass of copper B^1 in which it is able to slide and be fixed in the desired position by a set screw C^1; and D^1 is the plunging contact of iron or platinum which established contact at E^1 with the mercury F^1 contained in the vessel G^1. At the other extremity of the balance is the iron armature H^1 which is intended to be alternately attracted by the electromagnet I^1.

The point E^1 successively enters and leaves the mercury bath F^1 as a consequence of the successive oscillatory movements of the beam A^1 which is supported by the straight spring O^1, one end of which is inserted in the mass B^1 and the other in the supporting foot J^1.

K^1 is a spring fixed upon the beam and furnished with a small plate of platinum L^1 upon its upper portion. A screw M^1 having a platinum point serves to conduct the current to the point of contact with the platinised spring. This screw may, at the same time as it is raised or lowered by unscrewing or screwing it in its support, be laterally displaced along the line a^1 b^1 and make contact with the platinised spring at any point upon this latter, thus either approaching or receding from the centre of the beam.

The electro magnet I^1 may be either raised or lowered by means of a milled knob actuating a pinion gearing with the rack N^1.

The mercury cup G^1 may also be raised or lowered by means of a similar arrangement shewn in Figure 3.

Where radiography is concerned it is of the highest importance that the frequency of the currents should be variable; the radiographic tubes only give their maximum of X rays with a pre-determined frequency which explains the very poor results given by first class tubes and coils having a fixed frequency, because the current interruptions of these latter are not suitably proportioned to the tubes experimented with.

It is thus of the greatest importance to be able to cause this frequency to vary whilst operations are in progress, and this is obtained with the greatest ease by lateral displacement of the screw M^1 along the line a^1 b^1. The more this screw is pushed towards a^1, the greater becomes the rapidity of the trembler. The spring K^1 L^1 becoming less flexible in proportion as its foot is approached, no longer permits the screw M^1 to remain long in contact and this latter always rests slightly upon it, from which results an acceleration of the movement of the beam.

The intensity of the attraction of the armature also exerts considerable influence upon the rapidity of the interruptions; it should neither be too abrupt nor too weak in order that the rupture of the primary current may take place normally at E^1. In order to readily obtain the necessary magnetic adjustment, the electro magnet is raised and lowered as above indicated.

The primary current leaves the positive pole of the battery, reaches the vertical upright J^1 through the wire 5, then passes along the branch A^1 to the rod D immersed in the mercury. Thence it passes along the wire 6 to the primary winding E, which it leaves by the left hand terminal A and returns to the negative pole of the battery.

The circuit of the magnet I^1 is as follows:—the positive pole of the battery, upright J^1, lever arm A^1, spring L^1 screw M^1, wire 1, then the wire 4, electro magnet I^1, wire 3 and finally the wire 2.

As soon as the current traverses the electro magnet this latter contracts its armature. The shunt circuit is then opened by the spring L and immediately the lever A^1 returns to its original position, thus causing a series of interruptions which produce the opening of the primary circuit by the rod D and the mercury. These sudden ruptures in the primary circuit give in the secondary circuit H H a current which is hereafter utilised.

The mercury is covered by a stratum of ethylic alcohol whilst the apparatus is in action.

As in Ruhmkorff's coil, a condenser is employed, the armatures of which are respectively in communication with the two electrodes between which passes the spark on the rupture of the primary circuit, in order to absorb a portion of the extra current, and to render shorter the cessation of the current in the inducing circuit.

It has been observed that the period of rupture should be shorter than the period during which the current is closed in the primary circuit, and this in a manner which is variable with the intensity of the current employed, the self induction of the primary circuit and so forth.

The best conditions of duration and rupture of contact may be obtained by adjusting the height of the mercury cup by means of the knob actuating the rack which supports the cup.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. With the object of obtaining an electric transformer for currents at a high potential and having a variable frequency; (*a*) A primary circuit formed by a series of turns around an iron wire core lodged within a tube of insulating material, with interposition of insulating material between the walls of the tube and the winding. (*b*) A secondary circuit, the coils of which are formed by windings of wire with the interposition, between each winding, of sheets of paraffined paper, the said coils after having undergone an immersion of about 24 hours in a hot solution of paraffine in petroleum being connected in series, the two free wires passing to the interior of a tube of some insulating substance which, for powerful apparatus, may be formed by two concentric tubes with interposition of an insulating substance.

2. In the high pressure and variable frequency electrical transformer described in Claim 1, the immersion of a primary and a secondary circuit, arranged as above described, in a jelly formed by the cooling of a hot solution of paraffine in petroleum, of any other substance which is capable of forming a jelly on cooling, as above specified.

3. The combination with the high pressure, variable frequency electrical transformer described in the preceding claims, of an interruptor formed by a metal beam provided at one of its extremities with an iron armature intended to be attracted by the electro magnet when traversed by the current, and at its other extremity with a metal point entering a cup of mercury, the beam or balance thus constituted being supported by a vertical spring, the positions of the electro-magnet and mercury cup being capable of adjustment by means of racks provided for that purpose as above specified.

4. In the current interruptor described in Claim 3, a screw capable of vertical and lateral displacement above a flat spring fixed upon the beam and enabling the speed to be regulated whilst the apparatus is in operation, as above specified.

Dated this 12th day of October 1898.

HASELTINE, LAKE & Co.,
45, Southampton Buildings, London, W.C.,
Agents for the Applicants.

Redhill: Printed for Her Majesty's Stationery Office, by Malcomson & Co., Ltd.—1898.

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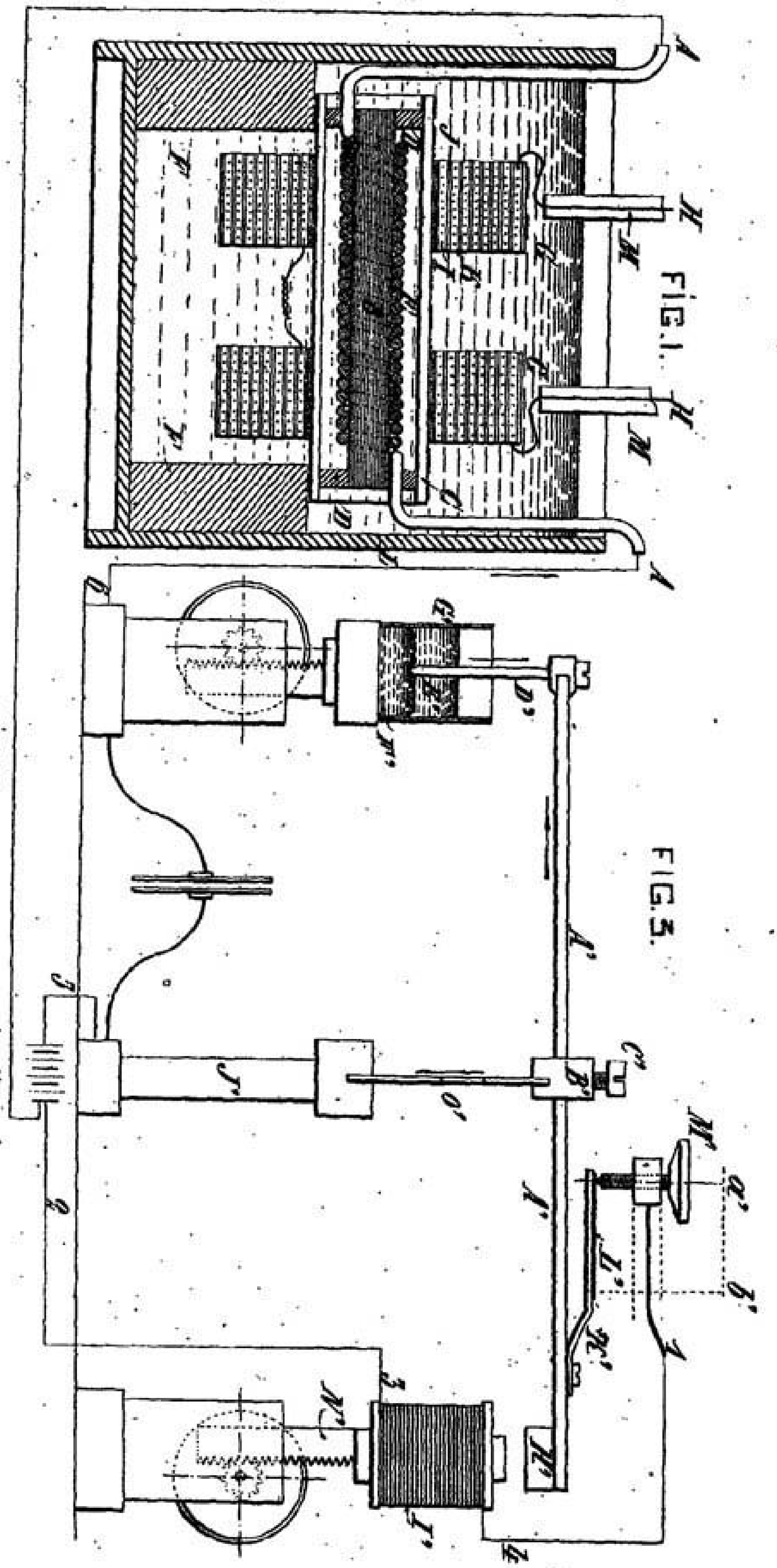


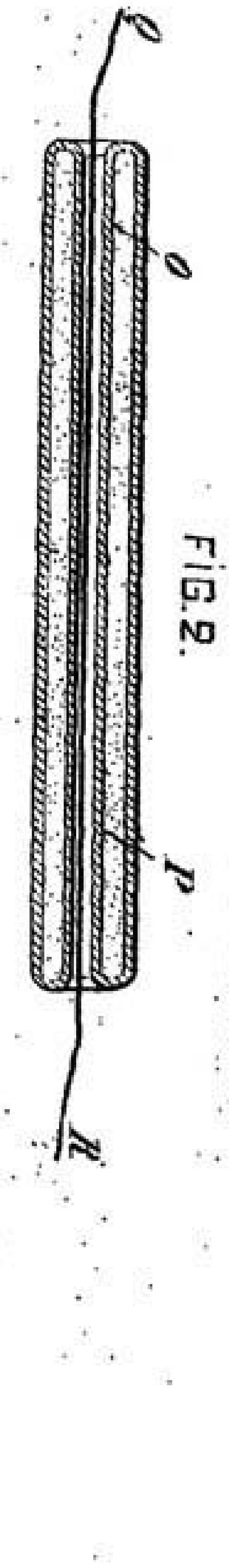


FIG.2.

[*This Drawing is a reproduction of the Original on a reduced scale.*]

Malby & Sons, Photo-Litho.

N° 13,969 A.D. 1898

Date of Application, 23rd June, 1898
Complete Specification Left, 20th Mar., 1899—Accepted, 22nd Apr., 1899

PROVISIONAL SPECIFICATION.

Improvements in Trembler Interruptors for Electric Currents.

We, Alfred Wydts and Octave Rochefort, both of 46, Boulevard Haussmann, Paris, in the Republic of France, Engineers, do hereby declare the nature of this invention to be as follows:—

This invention relates to certain improvements in trembler interruptors of electric currents which we have devised with the object of obtaining a rectilinear movement of the movable rods which, as a consequence of the operation of the apparatus, establish a contact in order to allow the current to pass, and then break this contact owing to the successive oscillations of these movable rods.

The armature which during the operations of the apparatus, is successively attracted by the electro-magnet and withdrawn by the flat counter spring, oscillates upon a support by means of the said spring. This armature is continued by a rod which is bent at its end and connected by means of a flat piece of foil or plate to a lower rod which enters a vessel containing the insulating liquid which covers the opposite electrode formed by the mercury placed at the bottom of the said vessel.

Owing to the successive attractions of the armature the point of the rod attached to the armature describes arcs of a circle around the top of the support and the lower portion of the rod does not describe a vertical rectilinear movement but a certain oscillatory movement producing a very violent eddy in the liquid contained in the vessel and consequently retarding the rapidity of the movement of the trembler.

These eddies also prevent the lower rod from making a good contact with the mercury, which is frequently projected by the sweeping movement produced by the rod.

In order to convert the oscillatory movement of the lower rod into a vertical rectilinear movement, we divide the rod into two portions and slightly flatten the immersed portion in order to increase the surface immersed in the liquid, so that this latter may oppose greater resistance to the movements of lateral displacement, which tend to be produced. We unite the two portions of the rod, by means of an exceedingly flexible foil spring as above indicated.

Owing to the very slight resistance of the sheet of foil, and owing, on the other hand, to the resistance offered by the liquid to the lateral displacement of the lower rod in the vessel this rod instead of receiving an oscillatory movement, has imparted to it a vertical rectilinear movement, because the sheet of foil will bend according to the position of the said rod.

It is obvious that, in order that the lower rod may remain vertical, it is absolutely necessary that the resistance of the part interposed between the two rods and in particular of the sheet of foil just referred to, should be less than the resistance opposed by the liquid to the inclined displacements of the lower rod. Instead of arranging between the rods a sheet of foil, it is obvious that we might provide any other resistance sufficiently weak to permit of the results which we have just considered. Thus, for example, the sheet of foil might be replaced by

[*Price 8d.*]

a spring of any kind, by a hinge, a ball and socket joint or by any other suitable device.

We do not desire to limit ourselves to the arrangement of the trembler interruptor above described. This arrangement, apart from the sheet of foil has no special importance.

Dated this 23rd day of June 1898.

HASELTINE, LAKE & Co.,
45, Southampton Buildings, London, W.C.,
Agents for the Applicants.

COMPLETE SPECIFICATION.

Improvements in Trembler Interruptors for Electric Currents.

We, Alfred Wydts and Octave Rochefort, both of 46, Boulevard Haussmann, Paris, in the Republic of France, Engineers, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to certain improvements in trembler interruptors of electric currents which we have devised with the object of obtaining a rectilinear movement of the movable rods which, as a consequence of the operation of the apparatus, establish a contact in order to allow the current to pass, and then break this contact owing to the successive oscillations of these movable rods.

In order that our invention may be clearly understood, we have represented in the accompanying drawings, by way of example, a trembler-interruptor provided with the improvements which form the subject of this invention.

Referring to the accompanying drawings in which:

Figure 1 is an elevation of a trembler interruptor for electric currents embodying our improvements.

Figure 2 is a perspective view showing the flexible connection between the two rods, and Figure 3 is a diagrammatic view hereinafter referred to.

The armature A which during the operation of the apparatus is successively attracted by the electro-magnet B and withdrawn by the flat counter spring *a*, oscillates upon a support C by means of the said spring *a*. The said armature A is continued by a rod D which is bent at its outer end as at *d* and connected by means of a flat piece of exceedingly flexible foil or plate F to a lower rod D^1 which enters a vessel E containing the insulating liquid which covers the opposite electrode formed by the mercury placed at the bottom of the said vessel E.

Owing to the successive attractions of the armature A, the point *d* describes arcs of a circle around the top of the support C, while the lower rod D^1 does not describe a vertical rectilinear movement but a certain oscillatory movement producing very violent eddies in the liquid contained in the vessel E and consequently retarding the rapidity of the movement of the trembler.

These eddies also prevent the lower rod D^1 from making a good contact with the mercury which is frequently projected by the sweeping movement produced by the rod.

In order to cause the lower rod D^1 to have a reciprocating vertical rectilinear movement we connect the said rod with the rod D by means of an exceedingly flexible piece of foil plate F (Figure 2) and slightly flatten the immersed portion of the rod D^1, in order to increase the surface exposed to the liquid, which thereby opposes greater resistance to any lateral displacement of the rod D^1 which may tend to be produced in the direction indicated by the arrows L L^1.

Owing to the very slight resistance of the sheet of foil, and owing, on the other hand, to the resistance offered by the liquid to the lateral displacement in the directions $Z\ Z^2$, of the rod D^1 in the vessel E, this rod D^1, instead of receiving an oscillatory movement, has imparted to it a vertical rectilinear movement, because the sheet of foil F will bend according to the position of the rod D.

If this movement be analysed (referring for this purpose to the diagrammatic view Figure 3) it will be seen that when the point d is at d_1, the rod D^1 remaining vertical, the sheet of foil F will be inclined from the right to the left hand. When the point d reaches the position d_2, the rod D^1 still remaining vertical, the sheet of foil F will be inclined from the left to the right hand. Finally, when the point d reaches the position d_3, the sheet of foil F will be inclined from the right to the left hand, and parallel with the first position which it occupied when the point d was at d_1.

It is obvious that, in order that the lower rod D^1 may remain vertical, it is absolutely necessary that the resistance of the part interposed between the two rods D D^1, and in particular of the sheet of foil just referred to, should be less than the resistance opposed by the liquid to the lateral or inclined displacement of the lower rod D^1. Under the conditions, and in view of the very great rapidity of the movement, the displacements of the sheet of foil will be those which we have considered.

Instead of arranging between the rods D and D^1 a sheet of foil, it is obvious that we might provide any other part of sufficiently weak resistance to permit of the results which we have just considered. Thus, for example, the sheet of foil might be replaced by a suitable spring of any kind, by a hinge, a ball and socket joint or by any other suitable device.

We do not desire to limit ourselves to the arrangement of the trembler interruptor above described and illustrated in the drawing. This arrangement, apart from the sheet of foil F, has no special importance.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

In trembler interruptors of electric currents, the adaptation to movable rods making contact through a liquid of a sheet of foil, hinge, spring, ball and socket joint or other suitable part, for the purpose of connecting such rods to the armatures of the electro-magnets, for the purpose of converting the oscillatory movements of the said rods into a vertical rectilinear movement, which takes place owing to the very slight resistance of the connecting part, and to the considerable resistance offered by the liquid to lateral displacement of the said rods.

Dated this 20th day of March 1899.

HASELTINE, LAKE & Co.,
45, Southampton Buildings, London, W.C.,
Agents for the Applicants.

Redhill: Printed for Her Majesty's Stationery Office, by Malcomson & Co., Ltd.—1899

N° 2428 A.D. 1898

Date of Application, 29th Jan., 1898

Complete Specification Left, 12th Oct., 1898—Accepted, 28th Jan., 1899

PROVISIONAL SPECIFICATION.

An Improved Electrical Transformer for Currents of High Potential and Variable Frequency.

We, Alfred Wydts and Octave Maximilien Rochefort, both of 46, Boulevard Haussmann, Paris, in the Republic of France, Engineers, do hereby declare the nature of this invention to be as follows:—

This invention relates to a novel electrical induction transformer of the Ruhmkorff type, especially applicable to the production of Crookes's radiations, to obtaining currents of high frequency, to ignition by the induction spark, to the operation of commercial and medical ozonaters and so forth.

The primary circuit is formed by a relatively large and short wire making a small number of turns around a central core of annealed iron wires which are insulated one from the other, in order to obviate, to a certain extent, the production of Foucault's currents and at the same time diminish "hystérésis."

This primary coil is enclosed in a tube of glass, crystal or any other suitable insulating substance and held in a central position by means of two washers of fibre or other insulating material, in such a manner that between the wires and the internal wall of the tube a free space is left into which is run an insulating substance.

The glass tube is itself supported by brackets suitably shaped for its reception, or in any other appropriate manner, at the centre of a vessel composed of an insulating substance such as glass, celluloid, porcelain or the like, which is subsequently filled with the insulating substance.

Upon the tube is arranged the secondary circuit composed in the following manner:

A certain number (according to the power of the apparatus) of elementary coils, constructed in the manner which is hereinafter explained, is arranged upon the glass tube; the coils are all connected in series and the two free end wires are connected to the secondary terminals of the apparatus, of which they constitute the two poles.

The secondary coils are formed in the following manner:

Upon a wooden mandrel, which is slightly conical in form so as to facilitate the dismounting of the coils, and which is mounted upon a disc or wheel which, in turning travels at the same time in the direction of its length, are stuck 5 or 6 sheets of paper which have been carefully paraffined and cut into strips of the same width as the elementary coils. These sheets of paper are superposed so as to form a paper tube of considerable strength, it will however be understood that this core may also be formed of card board, wood or the like without affecting the result obtained.

When this core has been formed, the coiling of the secondary wire may be commenced, care being taken to leave between each turn a slight interval which is afterwards filled up by the insulating substance. This first layer is then covered

[*Price* 8*d*.]

(1 SHEET)

Fig. 2.

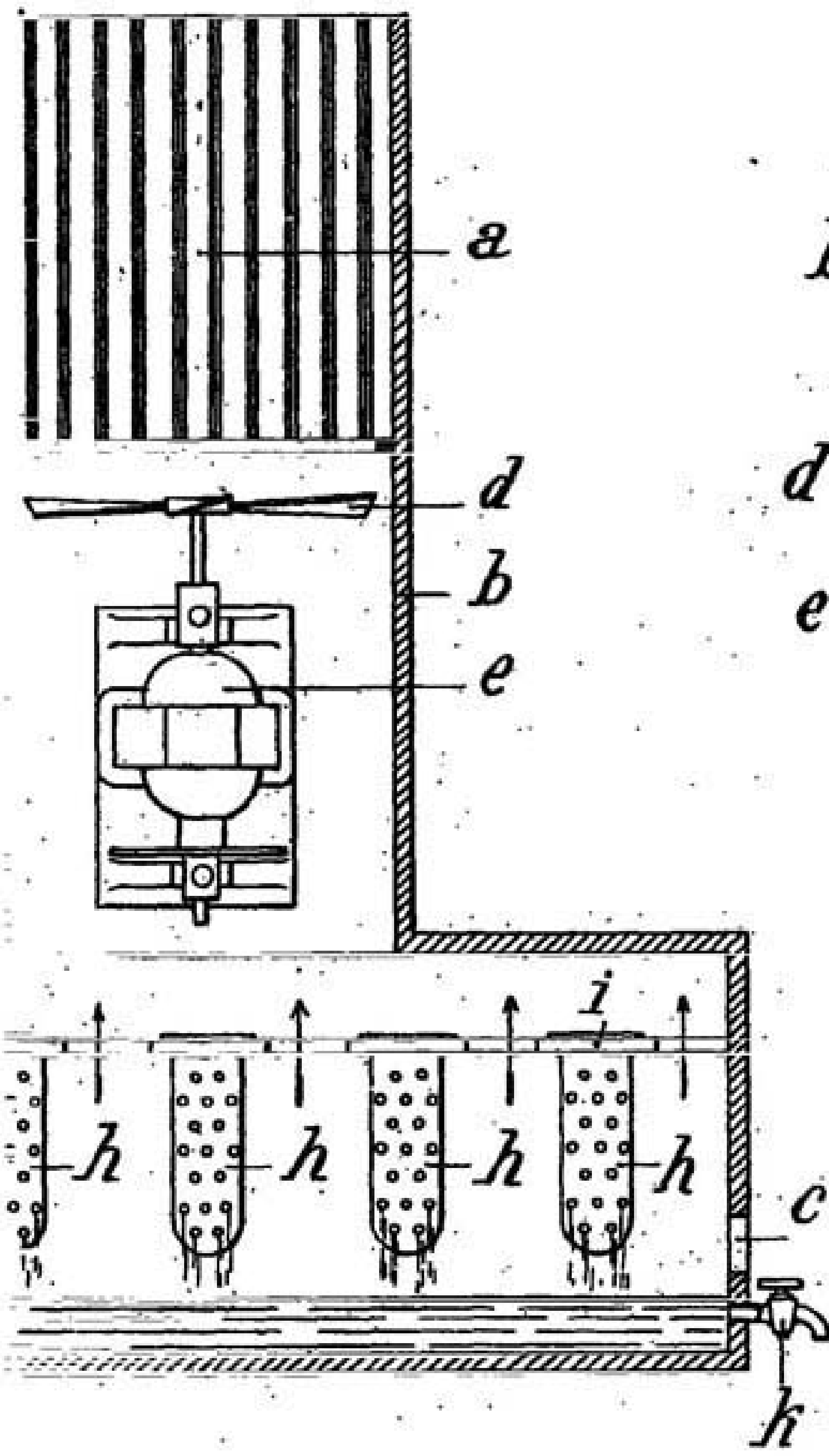
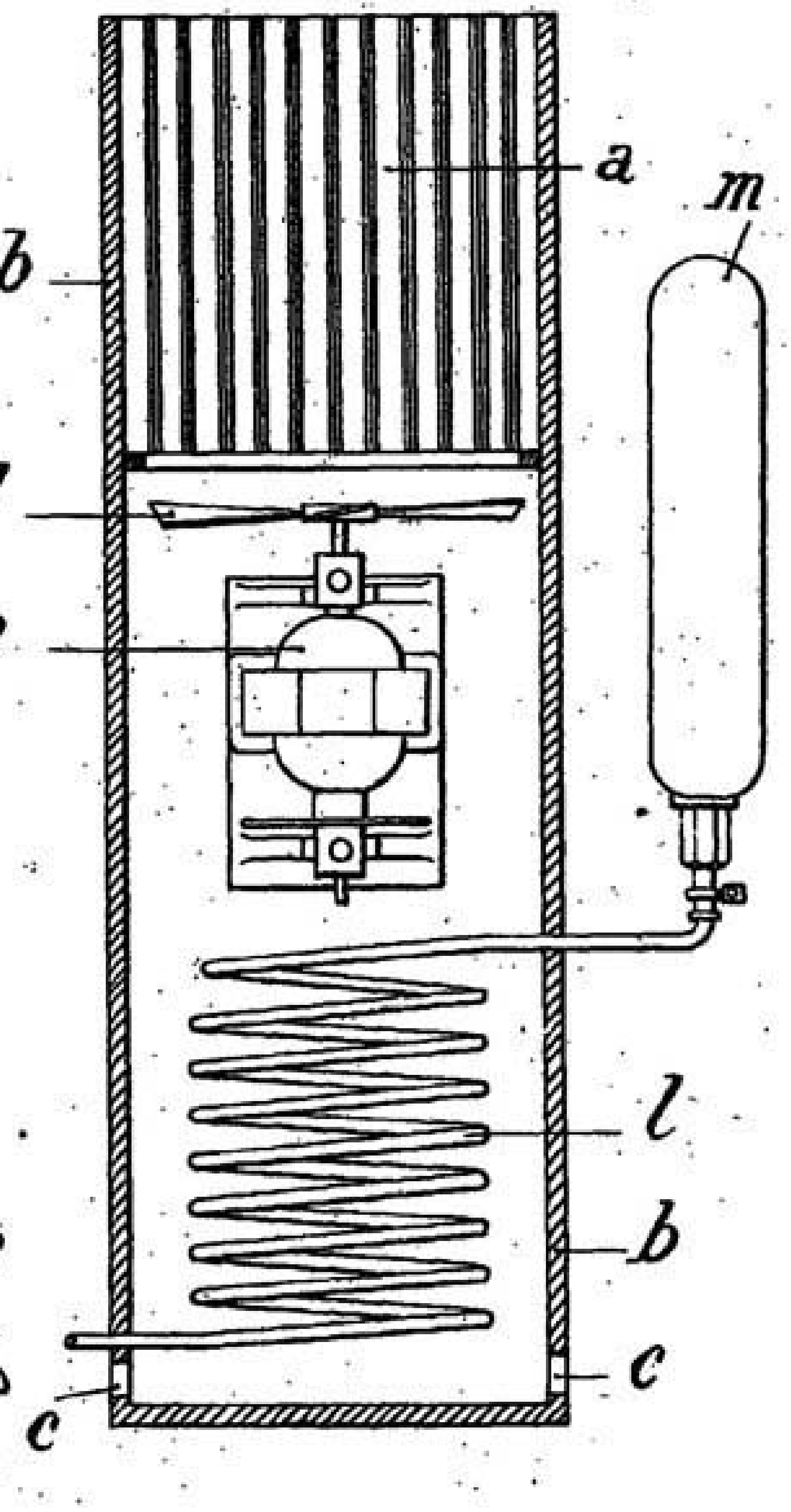


Fig. 3.



[This Drawing is a reproduction of the Original on a reduced scale]

Malby&Sons, Photo-Litho.

A method of employing liquid air which might be adopted in lieu of that mentioned above, would be to project into the place to be disinfected a grenade of liquid air, the place then being hermetically closed and the ozonizer set in operation.

In order that the method of carrying out the invention may be more clearly understood we have illustrated in the accompanying drawings by way of example the apparatus which may be used.

Figure 1 shows a sectional elevation of an ozonizing apparatus in which the air is cooled by means of ice. Figures 2 and 3 are similar views of ozonizers respectively adapted for the use of freezing mixtures and liquid carbonic acid.

The same letters of reference indicate the same parts in all the figures.

a is the ozonizer which may be of any known kind, placed at the upper part of a casing *b* which is provided at its lower part with openings *c* for the admission of air. *d* is a fan or other aspirating or exhausting device driven by an electric or other motor *e*. In Figure 1 the air entering at orifices *c* passes through a layer of ice *f* supported for example, upon a perforated diaphragm *g*.

In Figure 2 the air drawn in by the fan is brought into contact with perforated holders *h* containing a suitable freezing mixture and supported by a cross-bar or diaphragm *i*.

In both these apparatus a cock *k* is provided for drawing off the water of condensation.

In the arrangement shown in Figure 3, the air enters at orifices *c* and is cooled by contact with a refrigerating coil *l* which is supplied with liquid carbonic acid from a suitable bottle or container *m*. The carbonic acid may either escape freely into the casing or may be discharged at the exterior.

Dated this 14th day of December 1903.

A. M. & WM. CLARK,
Chartered Patent Agents, 53. Chancery Lane. London.

COMPLETE SPECIFICATION.

"Improvements in and Apparatus for Ozonizing Air for Disinfecting Purposes."

We, Arsène d'Arsonval (Member of the Institute) of 12. Rue Claude Bernard, Paris, France, Georges Eugène Gaiffe (Electrical Engineer), and Georges Gallot (Electrician) both of 9. Rue Méchain, Paris, France; do hereby declare the nature of this invention and in what manner the same is to be performed to be particularly described and ascertained in and by the following statement.

The employment of ozone for disinfecting insanitary places has been frequently attempted but with results which, notwithstanding the microbicidal property of this agent, are in practice inconsiderable. The want of success has been due to a variety of causes among the principal of which may be mentioned the exceedingly small quantity of ozone set in action relatively to the power employed in its production. It may in fact be remarked that the volume of air contained in any given space can only be charged with ozone to a degree dependent upon the temperature prevailing in the space in which the operation is being performed so that since, in the case of the disinfection of confined spaces, the temperature of the air in summer varies between 18° C and 25° C, it is scarcely possible to transform into ozone at most, more than a tenth part of the weight of the oxygen contained in the air. Moreover the germs and microbes to be destroyed are very often in a dry state and the microbes are the less easily acted on the less highly the atmosphere is charged with moisture.

The present invention relates to a process designed to remedy the above mentioned defect, the process consisting essentially in cooling and humidifying the air to such an extent as to permit of the air being ozonized so strongly as to effectually destroy the microbes which would otherwise escape the action of the ozone if the ordinary means of ozonizing the air were employed.

Premising that the invention is not dependent on any particular arrangement of apparatus the process may, speaking generally, be carried into effect by hermetically closing the place to be disinfected and, by means of a fan, causing the air contained therein to pass first over or through ice or a freezing mixture in order to cool and moisten it and then through an ozonizer which together with a fan is contained in the enclosed space.

Or the process may be carried into effect by allowing liquid air to slowly drop at a suitable point in the apparatus in order that this air as it volatilizes may at once pass through the ozonizer at a very low temperature. In the latter case the atmosphere of the place to be disinfected should be previously saturated with steam in order to moisten it.

Whatever may be the actual means adopted and the kind of apparatus employed in carrying out the process it is possible to obtain ozonized air charged with ozone to a far higher degree than has been hitherto possible.

The proportion of ozone obtained at 0° is as a matter of fact 15%, that is to say the proportion is higher by 50% than that obtained at + 20°, since as we have seen, the amount produced at the latter temperature does not exceed one-tenth or 10% of the proportion of oxygen treated. At – 20°, which is a temperature obtainable with certain known freezing mixtures 20% of ozone could be obtained. Finally if liquid air (which has a boiling point of – 180°) be employed, practically the whole of the oxygen may be transformed into ozone.

A method of employing liquid air which might be adopted in lieu of that mentioned above would be to project into the place to be disinfected a grenade of liquid air, the place then being hermetically closed and the ozonizer set in operation.

In order that the method of carrying out the invention may be more clearly understood we have illustrated in the drawings accompanying our Provisional Specification by way of example the apparatus which may be used.

Figure 1 shows a sectional elevation of an ozonizing apparatus in which the air is cooled by means of ice. Figures 2 and 3 are similar views of ozonizers respectively adapted for the use of freezing mixtures and liquid carbonic acid.

The same letters of reference indicate the same parts in all the figures.

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In both these apparatus a cock *k* is provided for drawing off the water of condensation.

In the arrangement shown in Figure 3, the air enters at orifices *c* and is cooled by contact with a refrigerating coil *l* which is supplied with liquid carbonic acid from a suitable bottle or container *m*. The carbonic acid may either escape freely into the casing or may be discharged at the exterior.

Having now particularly described and ascertained the nature of the said invention and in what manner the same is to be performed, we declare that what we claim is.

1. Process of ozonizing air for disinfecting purposes which consists in cooling

and humidifying the air or oxygen and then passing it through an ozonizer, substantially as specified.

2. The apparatus for carrying the process into effect constructed substantially as described and illustrated in the drawings.

3. The employment of liquid air substantially in the manner specified for the production of ozone and the disinfection of confined and insanitary spaces.

Dated this 29th day of August 1904.

A. M. & WM. CLARK,
Chartered Patent Agents, 53. Chancery Lane. London.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1904.

Fig. 1.

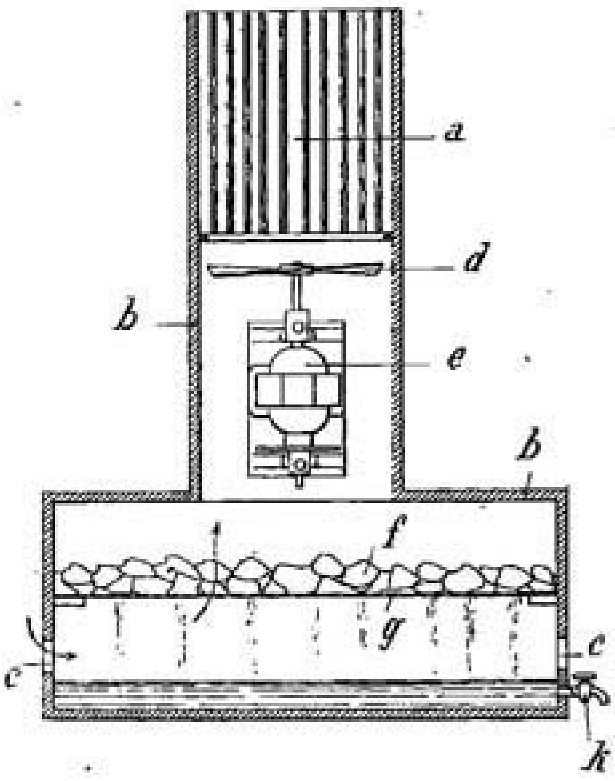


Fig. 2.

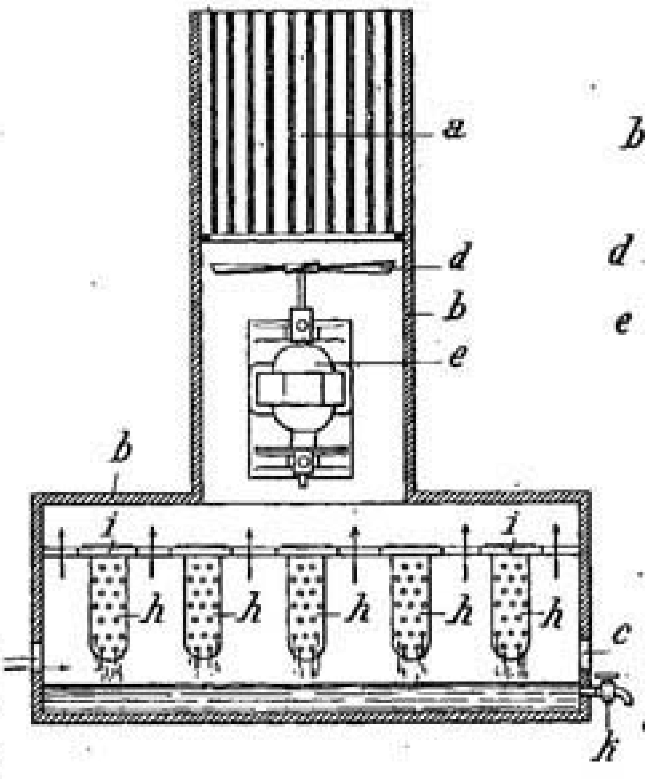
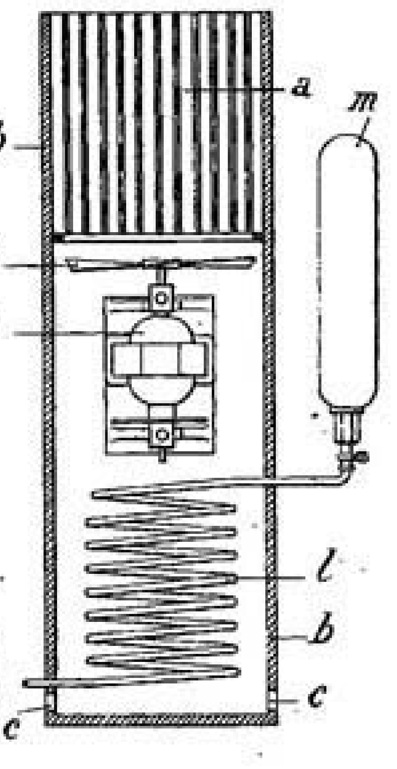


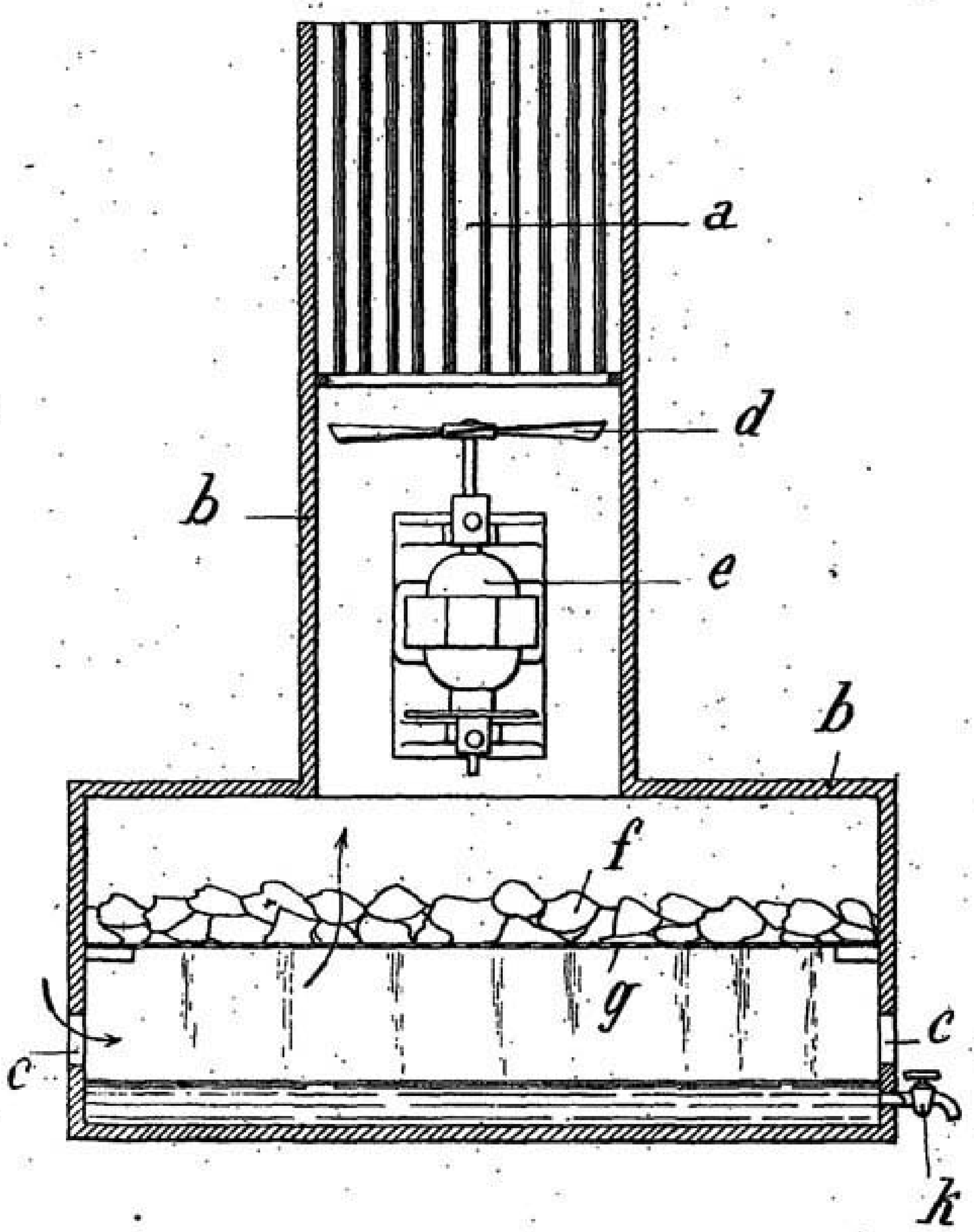
Fig. 3.

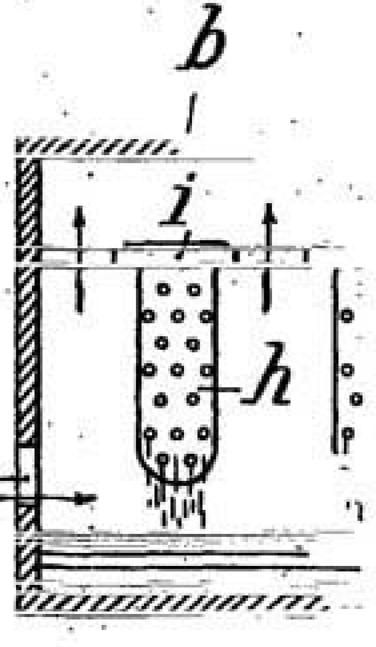


[This Drawing is a reproduction of the Original on a reduced scale]

Malby & Sons, Photo-Litho.

Fig. 1.





Nº 27,358 A.D. 1903

Date of Application, 14th Dec., 1903

Complete Specification Left, 29th Aug., 1904—Accepted, 29th Sept., 1904

PROVISIONAL SPECIFICATION.

"Improvements in and Apparatus for Ozonizing Air for Disinfecting Purposes."

We, Arsène d'Arsonval (Member of the Institute) of 12. Rue Claude Bernard, Paris, France, Georges Eugène Gaiffe (Electrical Engineer), and Georges Gallot (Electrician) both of 9. Rue Méchain, Paris, France; do hereby declare the nature of this invention to be as follows:—

The employment of ozone for disinfecting insanitary places has been frequently attempted but with results which notwithstanding the microbicidal property of this agent are in practice inconsiderable. The want of success has been due to a variety of causes among the principal of which may be mentioned the exceedingly small quantity of ozone set in action relatively to the power employed in its production. It may in fact be remarked that the volume of air contained in any given space can only be charged with ozone to a degree dependent upon the temperature prevailing in the space in which the operation is being performed so that since, in the case of the disinfection of confined spaces, the temperature of the air in summer varies between 18° C and 25° C, it is scarcely possible to transform into ozone at most, more than a tenth part of the weight of the oxygen contained in the air. Moreover the germs and microbes to be destroyed are very often in a dry state and the microbes are the less easily acted on the less highly the atmosphere is charged with moisture.

The present invention relates to a process designed to remedy the above mentioned defect, the process consisting essentially in cooling and humidifying the air to such an extent as to permit of the air being ozonized so strongly as to effectually destroy the microbes which would otherwise escape the action of the ozone if the ordinary means of ozonizing the air were employed.

Premising that the invention is not dependent on any particular arrangement of apparatus, the process may, speaking generally, be carried into effect by hermetically closing the place to be disinfected and by means of a fan causing the air contained therein to pass first over or through ice or a freezing mixture in order to cool and moisten it, and then through an ozonizer which together with a fan is contained in the enclosed space.

Or the process may be carried into effect by allowing liquid air to slowly drop at a suitable point in the apparatus in order that this air as it volatilizes may at once pass through the ozonizer at a very low temperature. In the latter case the atmosphere of the place to be disinfected should be previously saturated with steam in order to moisten it.

Whatever may be the actual means adopted and the kind of apparatus employed in carrying out the process, it is possible to obtain ozonized air charged with ozone to a far higher degree than has been hitherto possible.

The proportion of ozone obtained at 0° is as a matter of fact 15%, that is to say the proportion is higher by 50% than that obtained at + 20°, since as we have seen the amount produced at the latter temperature does not exceed one-tenth or 10% of the proportion of oxygen treated. At —20°, which is a temperature obtainable with certain known freezing mixtures, 20% of ozone could be obtained. Finally if liquid air (which has a boiling point of —180°) be employed practically the whole of the oxygen may be transformed into ozone.

[*Price 8d.*]

angle iron support within the cabinet secured to the corner posts, and panels secured to the side flanges of the corner moldings, the support comprising an angle iron bar bent to form an open rectangular frame and having its free ends spot welded.

2. A cabinet comprising a base, corner posts secured to the base, sheet metal corner moldings resting upon the base and enclosing the posts provided with side flanges, threaded studs affixed in and projecting from the side flanges, a top supported upon and secured to the corner posts, panels provided with a plurality of holes through which the threaded studs are extended, and nuts on said studs for clamping the panels to the side flanges.

CHARLES EDWARD CAMPBELL.

Patented June 7, 1927. **1,631,718**

UNITED STATES PATENT OFFICE.

CHARLES EDWARD CAMPBELL, OF LYNN, MASSACHUSETTS, ASSIGNOR TO CAMPBELL ELECTRIC COMPANY, OF LYNN, MASSACHUSETTS, A CORPORATION OF MASSACHUSETTS.

CABINET.

Application filed June 14, 1920, Serial No. 388,777. Renewed May 1, 1926.

This invention relates to a cabinet for X-ray units and the like.

The object of the invention is to produce a cabinet for X-ray units and the like of improved construction, which may be manufactured economically, assembled easily, is strong and durable, and which presents a very attractive and pleasing appearance.

To these ends, the invention consists in the cabinet hereinafter described and claimed. In the drawing illustrating the preferred embodiment of the invention, Figure 1 is a perspective of the improved cabinet with a portion broken away; Fig. 2 is a sectional detail of a corner of the cabinet taken on the line 2—2 of Fig. 1; Fig. 3 is a detail illustrating the manner of forming the corner joint of the angle iron support; and Fig. 4 is a detail on the line 4—4 of Fig. 1, showing the reenforcing plates for the corner moldings.

Referring to the drawing, the cabinet comprises a relatively heavy base 10 and a top 12, preferably of marble. The top 12 rests upon shoulders 14 formed upon the upper ends of four corner posts 16. The corner posts 16 are provided with reduced lower ends which are threaded and screwed into threaded holes in the base 10. The top 12 is secured in place by nuts 18 screwed onto reduced upper ends of the posts 16, which are suitably threaded and extended through holes in the top 12. The base 10, top 12 and corner posts 16 constitute the frame of the cabinet.

Preformed supports 20 are secured in place within the cabinet, one at the top and one at a point intermediate the top 12 and base 10. Each of the supports 20 comprises an open rectangular angle iron frame secured within the cabinet in position with one flange 21 horizontal. The supports 20 are secured to the corner posts 16 by screws 23 (see Fig. 2) extended through holes 24 in the corners of the vertical flange of the angle iron frame. Corner blocks 25 are employed to afford bearings for the heads of the screws 23 and to assist in clamping the supports to the corner posts in the manner illustrated in Fig. 2. The supports 20 are each formed from a single angle iron bar bent into rectangular shape. Triangular portions 22 of the flange 21 are cut away in order that when the bar is bent into rectangular shape, flush joints may be secured at three of the corners. The ends of the flange 21 are bevelled off to provide a flush joint at the fourth corner and a unitary structure is secured by spot welding the bevelled ends of the flange.

The sides of the cabinet are closed by sheet metal panels 30. The panels 30 are provided with a plurality of holes near their side edges located so as to cooperate with threaded studs 32 fixed in and projecting from side flanges 34 of corner moldings 36. The panels 30 are held in place by nuts 38 screwed onto the ends of the studs 32. The corner moldings 36 are of heavy gage sheet metal and are stamped into the form illustrated in section in Fig. 2. The corner moldings may have any desired shape in cross section to enhance the appearance of the cabinet at the corners. The corner moldings partially enclose the corner posts 16 and are frictionally secured thereto. The ends of the side flanges 34 of the corner moldings are folded under to afford sufficient thickness of metal to retain the studs 32 and to act as stiffening strips for the support of the panels 30. In some instances it may be desirable to reenforce the corner moldings and for this purpose plates 42 are secured to the corner posts by screws 43 and the studs 32 are extended through the side flanges 34 of the corner molding and into the plates 42.

In assembling the cabinet, the corner posts 16 are screwed into the base 10. The preformed supports 20 are then secured to the corner posts and thereafter the four corner moldings 36 are slipped into place over the upper ends of the corner posts. The top 12 is then dropped over the upper reduced ends of the corner posts and secured thereto by the nuts 18. The panels 30 are then secured to the side flanges of the corner moldings, thus completing the cabinet. It will be observed that the finished cabinet presents the impression of great strength due to the massive appearance of the corner moldings and the weight thereof is maintained at a minimum.

Having thus described the invention, what is claimed is:

1. A cabinet comprising a base, corner posts secured to the base, sheet metal corner moldings enclosing the corner posts provided with side flanges, a top supported upon and secured to the corner posts, an

June 7, 1927. C. E. CAMPBELL 1,631,718

CABINET

Original Filed June 14, 1920

Fig.1

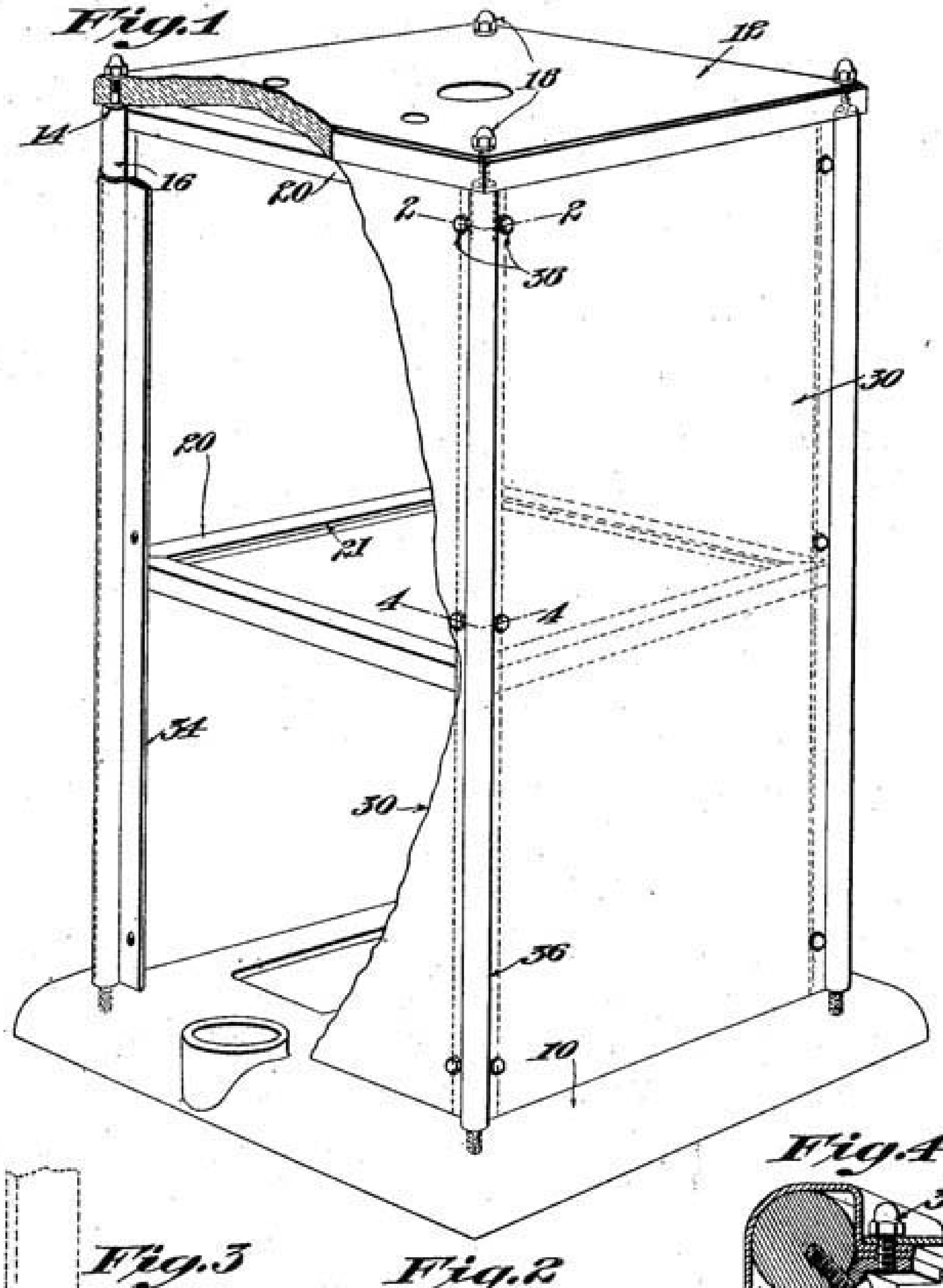


Fig.3

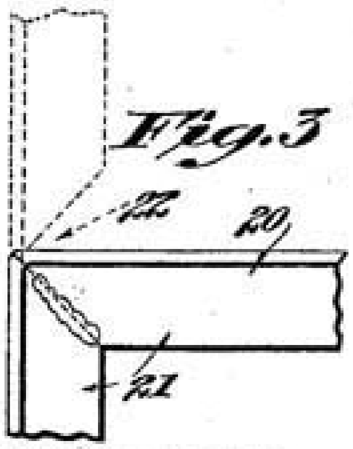


Fig.2

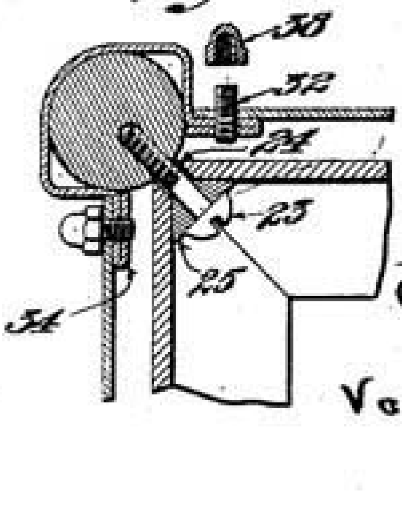
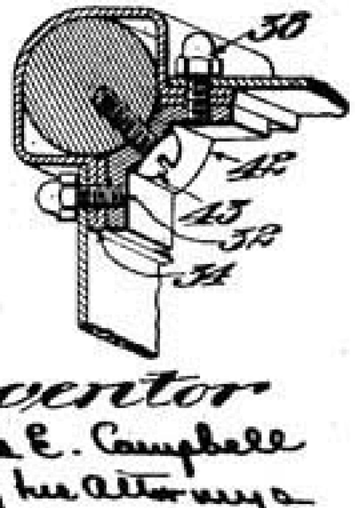


Fig.4



Witness

M. G. Crozier

Inventor

Charles E. Campbell

by his Attorneys

Von Everen Fish & Hildreth

and the socket 10, the cord 20 leading to any convenient source of current.

It is an important feature of my lamp that I make the reflector and the base portion in one piece and thereby gain a light and rigid structure without the possibility that these two members can move with respect to one another under normal conditions of use.

Furthermore, the parts within the lamp are retained in their proper positions and this is particularly true of the relation of the bulb with respect to the reflector for the reason that the bulb cannot shift from its correct focal position. The advantages of this in effectiveness of use are obvious and are not found elsewhere.

The structure of my device permits of facility in manufacture and, while I may prefer to spin it from a single sheet of metal, many methods may be used to produce my lamp in a simple and inexpensive manner.

In operation my lamp is used as are other therapeutic lamps, the current being controlled by the throw 9 of the switch 8; this throw being most conveniently located for operation by the hand of the one holding the lamp.

From the foregoing it is clear that my invention embodies new and novel advantages not found in other lamps of like class and that other superiorities accrue from the rigidity of the structure, ease of manufacture, and from facility of control in the use of my lamp.

Many variations and changes can be made from the preferred embodiment of my lamp as described and shown without departing from the spirit of my invention and I desire to have my claims interpreted with such variations and changes in mind.

I claim:

1. A lamp including a reflecting member and a base member formed in one piece, a switch member in the base, the actuating element of which projects through an opening in said base, a bulb holding member in the base, and a positioning member in said base in threaded relation with said bulb holding member.

2. A lamp including a reflector and base formed in one piece, a lamp socket and a switch member in said base and a threaded ring adapted to engage and support and position said socket and switch member against the inner wall of said base.

In testimony whereof, I have signed my name to this specification this 11th day of March, 1924.

CARL GEORGE GROSS.

Patented Aug. 26, 1924. **1,506,344**

UNITED STATES PATENT OFFICE.

BENNO F. JANCKE, OF BROOKLYN, NEW YORK, ASSIGNOR TO EASTERN LABORATORIES, INC., OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

VIOLET-RAY GENERATOR.

Application filed January 31, 1923. Serial No. 616,091.

To all whom it may concern:

Be it known that I, BENNO FREDERICK JANCKE, a citizen of the German Republic, and residing at Number 1406 Pacific Street, in the borough of Brooklyn, city and State of New York, have invented certain new and useful Improvements in Violet-Ray Generators, of which the following is a specification.

This invention relates to violet ray generators of the applicator type, that is, designed primarily for therapeutic use, and aims to provide improvements therein.

The invention provides a device of the character referred to, of simple construction, capable of ready and economical manufacture, and hence capable of sale at a popular price.

An embodiment of the invention is illustrated in the accompanying drawings, in which—

Figure 1 is a longitudinal sectional view of the generator showing a so-called applicator connected thereto.

Fig. 2 is a view partly in section and partly in elevation of a spool or framework, in which the various electrical parts are conveniently mounted.

Fig. 3 is a diagrammatic view showing the electrical construction and arrangement.

Referring to said drawings, numeral 10 designates a spool or framework, having a socket or other means of attachment 12 in one end, adapted to hold an electrode 14 of the applicator type therein and within which is generated the violet ray to which the therapeutic action of the device is due. This spool 10 is adapted to fit within a tube or sleeve 16, and the spool is conveniently formed with a head 18 at one end, which closes one end of said tube, said head 18 being preferably slightly tapered as indicated at 19, so as to enter the tube easily and make a tight fit therewith, said head also being conveniently formed with a shoulder 20 against which the end of the tube 16 abuts. Behind the head 18 the spool is of reduced diameter, as indicated at 25, 26, to afford space within the tube 16 for the primary and secondary windings 27, 28 of the high-tension transformer or spark coil 30, and for a choke-coil or inductance 32 and a condenser 34. The end 37 of the spool is conveniently of enlarged diameter, corresponding to the inside diameter of the tube 16, and serves to support the said tube, and also to form a support or base for the interrupter or sparking electrodes 40, 41. The spool 10 is also preferably provided with an annular enlargement 44 about midway between the head 18 and the opposite enlargement 37, and of a diameter corresponding to that of the tube 16, which serves to support the middle portion of said tube and divides the space between the ends of the spool.

On the end enlargement 37 there is conveniently provided two posts 46 which support a bridge piece 47, and preferably also a disc 48, of insulating material. The sparking electrode 41 is supported by said bridge piece 47, the said electrode being preferably mounted on a threaded rod 49 by means of which the distance apart of the electrodes 40, 41 may be adjusted and the intensity of the violet ray controlled. The tube 16 preferably extends beyond said disk 48, so as to close the adjacent end of said tube and consequently enclose the parts on the end portion 37 of said spool.

The spool 10 is preferably bored at each end, as indicated at 50, 51, the former serving for the reception of an iron core for strengthening the magnetic effect of the choke-coil 32. The recess 51 serves for receiving a tang 54 on a conducting thimble 55, and connection of the end of the secondary winding 28, to the tang 54 is conveniently made through a small hole 57.

The electrical arrangement is conventional, the secondary 28 being connected to the applicator 14, at one end as indicated at 60, Fig. 3, and grounded on the primary 27, as indicated at 61. The primary is connected to the lead wire 70 through a conductor 71 on one side, and to lead wire 73 through choke-coil or inductance 32, interrupter or sparking electrodes 40, 41, and conductor 74 on the other side. The condenser 34 is placed in shunt with the primary 27 by wires 76, 77, 78 leading to conductor 71, and to the interrupter 40, 41. An oscillatory discharge is produced between the sparking electrodes 40, 41, which sets up oscillations in the primary 27, thereby inducing high-tension currents in the secondary 28, thereby producing the violet-ray discharge in the rarefied applicator tube 14.

The inventive idea may receive other embodiments than that herein specifically illustrated and described.

What I claim is:

1. A violet ray generator, comprising a spool or frame, having portions of reduced diameter, coils and a condenser on said reduced portion, and a tube adapted to slip onto said spool and cover said coils and condenser, said spool having portions having a diameter corresponding to that of said tube for supporting the same.

2. A violet ray generator, comprising a spool or frame, having portions of reduced diameter, coils and a condenser on said reduced portion, and a tube adapted to slip onto said spool and cover said coils and condenser, said spool having portions having a diameter corresponding to that of said tube for supporting the same, one of said tube-supporting portions constituting a head and having an applicator-socket therein.

3. A violet ray generator, comprising a spool or frame, having portions of reduced diameter, coils and a condenser on said reduced portion, and a tube adapted to slip onto said spool and cover said coils and condenser, said spool having portions having a diameter corresponding to that of said tube for supporting the same, said tube being an open-ended tube of substantially uniform diameter.

4. A violet ray generator, comprising a spool or frame, having portions of reduced diameter, coils and a condenser on said reduced portion, and a tube adapted to slip onto said spool and cover said coils and condenser, said spool having portions having a diameter corresponding to that of said tube for supporting the same, said tube being an open-ended tube of substantially uniform diameter, one of said tube-supporting portions constituting a head and having an applicator-socket therein.

5. A violet ray generator, comprising a spool or frame, having portions of reduced diameter, coils and a condenser on said reduced portion, and a tube adapted to slip onto said spool and cover said coils and condenser, said spool having portions having a diameter corresponding to that of said tube for supporting the same, said generator further comprising an interrupter supported on one of said tube-supporting sections.

6. A violet ray generator, comprising a spool or frame, having portions of reduced diameter, coils and a condenser on said reduced portion, and a tube adapted to slip onto said spool and cover said coils and condenser, said spool having portions having a diameter corresponding to that of said tube for supporting the same, said generator further comprising an interrupter supported on one of said tube-supporting sections, said tube supporting portion being situated inward from an end of said tube, whereby the parts thereon are encased by said tube.

7. A violet ray generator, comprising a spool or frame, having portions of reduced diameter, coils and a condenser on said reduced portion, and a tube adapted to slip onto said spool and cover said coils and condenser, said spool having portions having a diameter corresponding to that of said tube for supporting the same, said generator further comprising an interrupter supported on one of said tube-supporting sections, said tube supporting portion being situated inward from an end of said tube, whereby the parts thereon are encased by said tube, said tube-supporting portion further having posts thereon and a disc on said posts beyond said interrupter, adapted to close the end of said tube.

8. A violet ray generator, comprising a spool or frame, having portions of reduced diameter, coils and a condenser on said reduced portion, and a tube adapted to slip onto said spool and cover said coils and condenser, said spool having portions having a diameter corresponding to that of said tube for supporting the same, said spool having a longitudinal recess therein, and an iron core therein for strengthening the field of one of said coils.

9. A violet ray generator, comprising a spool or frame, having portions of reduced diameter, coils and a condenser on said reduced portion, and a tube adapted to slip onto said spool and cover said coils and condenser, said spool having portions having a diameter corresponding to that of said tube for supporting the same, one of said tube-supporting portions constituting a head and having an applicator-socket therein, said spool having a thimble in said head, and a recess extending into the reduced portion of said spool through which connection between a coil on said spool and said thimble may be made.

In witness whereof, I have hereunto signed my name.

BENNO F. JANCKE.

April 20, 1926. 1,582,005

C. G. GROSS

THERAPEUTIC LAMP

Filed March 15, 1924

Fig. 1.

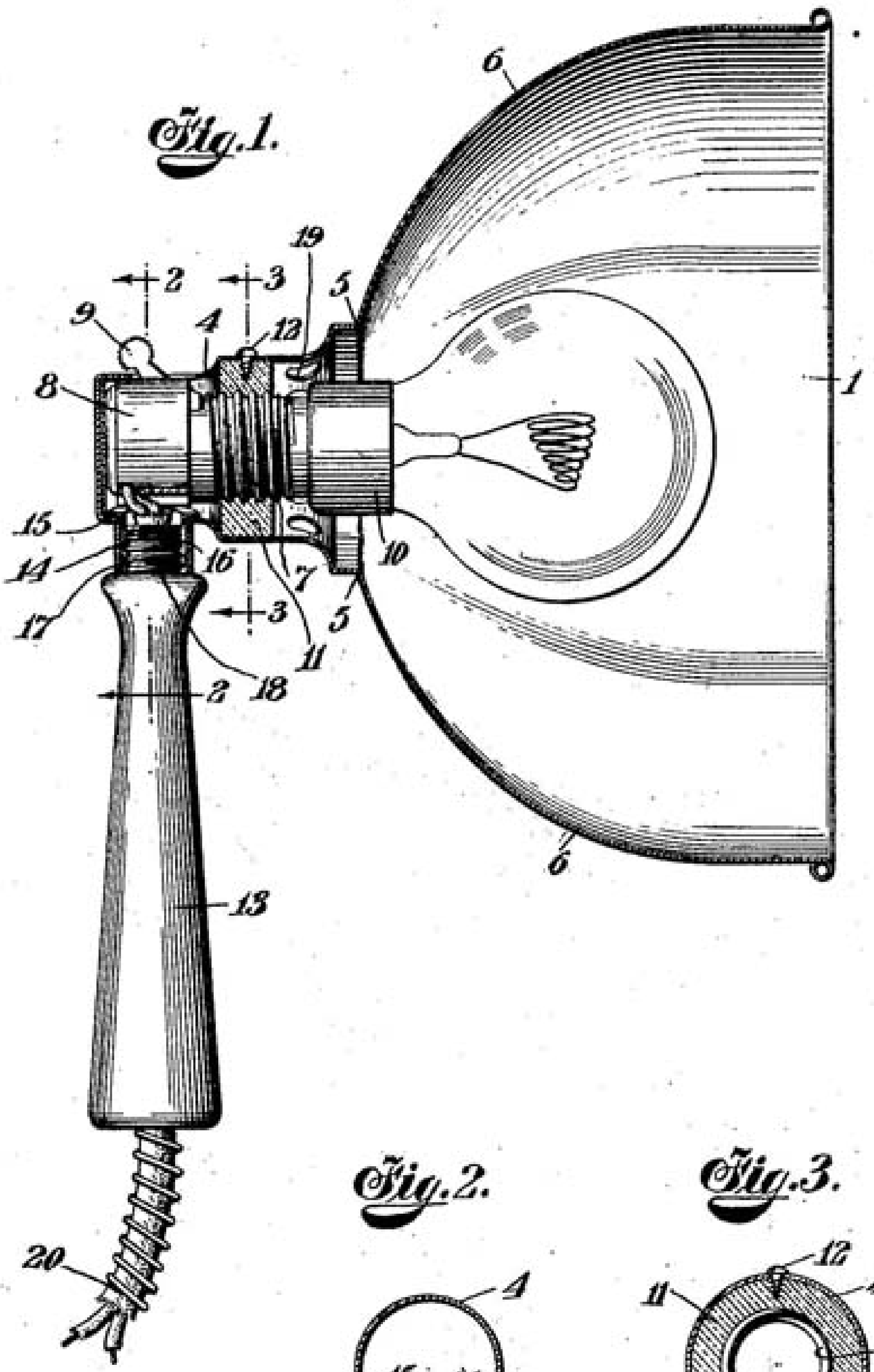


Fig. 2.

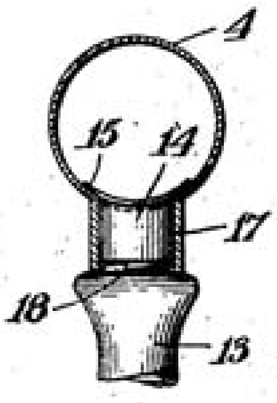
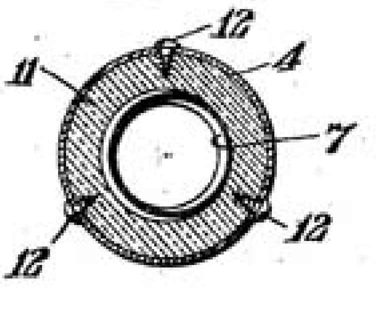


Fig. 3.



INVENTOR
Carl G. Gross
BY
Ramsay Hoguet
ATTORNEY

Patented Apr. 20, 1926. **1,582,005**

UNITED STATES PATENT OFFICE.

CARL GEORGE GROSS, OF MOUNT VERNON, NEW YORK, ASSIGNOR TO EASTERN LABORATORIES, INC., OF NEW YORK, N. Y.

THERAPEUTIC LAMP.

Application filed March 15, 1924. Serial No. 699,465.

To all whom it may concern:

Be it known that I, CARL G. GROSS, a citizen of the United States, and a resident of Mount Vernon, Westchester County, New York, have invented an Improvement in Therapeutic Lamps, of which the following is a specification.

My device relates in general to electric portable lamps and in particular to therapeutic lamps of this class.

My invention covers a lamp which is light and compact and in which there is a maximum reflection of rays and a particular type of construction which gives my lamp advantages not found in others.

I describe a preferred form of my lamp in the following specification and drawings from which the nature and objects of my invention will be made clear. In the drawings, like numbers refer to like parts throughout.

I show in:

Fig. 1 a sectional elevation of the entire lamp.

Fig. 2 a section through 2—2 of the base and handle.

Fig. 3 a section through 3—3 of the base.

In the form chosen for illustration, I show a parabolic reflector 1 with which is a base 4. While the base and reflector are preferably indicated as being formed in one piece, they may be equally well made in two parts if found desirable.

This reflector, or hood, 1 has a polished arc on its inner curvature which I have indicated as extending from 5 to 6 but which obviously may extend over as much of the inner curvature as may be desired. While I make this hood of a material which is capable of being polished and secure advantages in weight and simplicity thereby, any suitable reflector may be used without affecting the proper operations of the lamp.

In the base 4 is a socket, or receptacle, 7 and a switch 8 having a throw 9. This socket and switch are connected in any approved manner as is customary; in this case I show them fixedly attached one to the other. In the socket 7 is a bulb 10 of a size and capacity as may be found suitable under given conditions.

Within the base 4 is a positioning, or adjusting ring 11 held in place by screws 12 passing through base 4 into said ring 11. The center opening of this ring is threaded to fit the threads of the socket 7 as shown. The function of this ring 11 is twofold. It is inserted by screwing down over the socket 7 and, being a close fit within the base 4, the socket is held central within the base and the bulb 10 accurately located on the axis of the reflector 1.

The other function of the ring 11 is to position the bulb 10 at its correct focal point with regard to the reflector 1.

It is clear that the combined switch 8 and socket 7 have a certain degree of longitudinal movement within the base 4 and that the bulb 10 may be moved to the same extent. Consequently, after once having located the bulb 10 in its proper focal position and the ring 11 set, similar bulbs in duplicate lamps may be quickly and easily focused by first setting each ring in its predetermined position. Furthermore, different positionings of the bulb 10 with regard to the reflector 1 are possible by varying the longitudinal location of ring 11 in base 4.

I also provide a novel method of attaching a holding member to my lamp; in this instance a handle 13. In the base 4 is a circular opening and extending through this opening is a stud 14. This stud 14 has a curved flange 15 which seats in the inner curvature of the base 4. The stud 14 is internally threaded as at 16. Fitting over this stud 14 and abutting the base 4 is a nipple or the like, 17, which is made somewhat longer than that portion of the stud 14 which extends outwardly from the base 4. The handle 13 has a threaded projection 18, said threads being adapted to engage with the internal threads of stud 14. Therefore the handle 13 with projection 18 is screwed into stud 14, the two are brought together under the screw action until the nipple 17 abuts tightly against both the base 4 and the handle 13, and thereby forming a strong and rigid connection of the handle to the lamp; one simple to make and to apply.

In the base 4, I provide openings 19 which afford a degree of ventilation and prevent any appreciable amount of heat from reaching back into the base, although it is evident that these openings are optional and not a necessity. The electrical connections to the bulb 10 are made in the customary manner through the handle 13 to the switch 8

Aug. 26, 1924. 1,506,344

B. F. JANCKE

VIOLET RAY GENERATOR

Filed Jan. 31, 1923

Fig. 1.

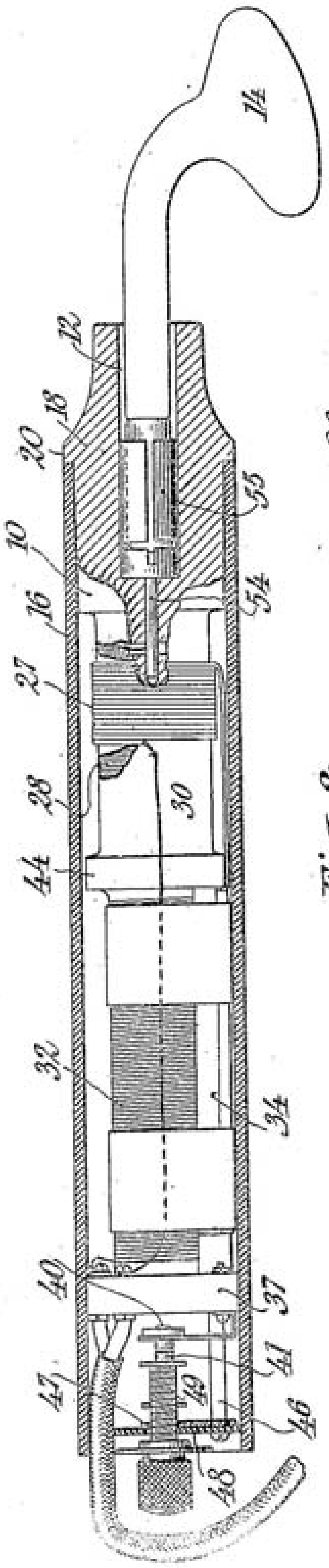


Fig. 2.

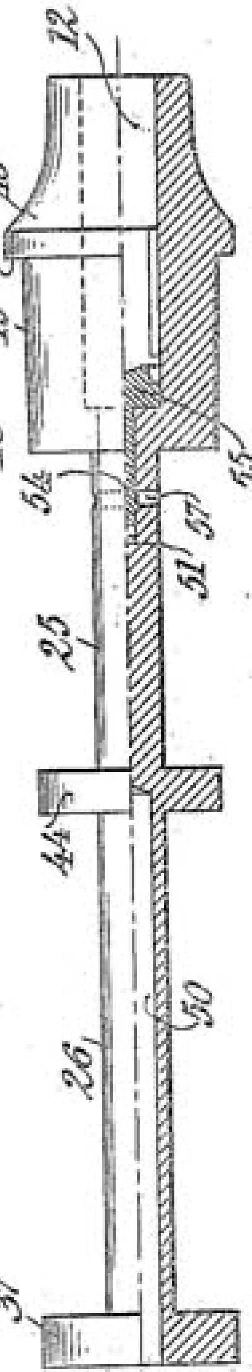
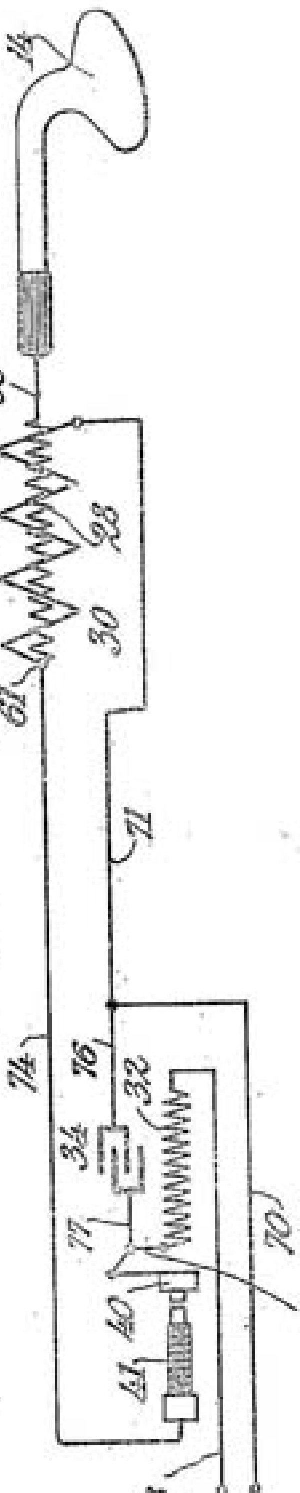


Fig. 3.



INVENTOR

Benno F. Jancke

By Attorneys,

therefor, a substantially clear glass filter for filtering out non-penetrating relatively long wave length infra-red rays, a second filter spaced from the first filter and comprising a body of substantially clear glass having on a surface thereof a thin film of ruby glass, said second filter serving to filter out long wave length infra-red rays which may have their source at the first filter, and the ruby glass film serving to filter out rays in the visible band having wave lengths shorter than that of red rays, and means mounting the filters so that air currents may move past both surfaces of each filter for cooling purposes.

3. A radiant energy lamp for radiating penetrating visible red and short infra-red rays comprising in combination, a light source, a reflector therefor, a substantially clear glass filter for filtering out non-penetrating relatively long wave length infra-red rays, a second filter spaced from the first filter and comprising a body of substantially clear glass having on a surface thereof a thin film of ruby glass colored by the introduction of a metal selected from the group consisting of copper and gold, said second filter serving to filter out long wave length infra-red rays which may have their source at the first filter, and the ruby glass film serving to filter out rays in the visible band having wave lengths shorter than that of red rays.

4. A radiant energy lamp for radiating penetrating visible red and short infra-red rays comprising in combination, a light source, a reflector therefor, a substantially clear glass filter for filtering out non-penetrating relatively long wave length infra-red rays, a second filter spaced from the first filter and comprising a body of substantially clear glass having on only one surface thereof a thin film of ruby glass colored by the introduction of a metal selected from the group consisting of copper and gold, said second filter serving to filter out long wave length infra-red rays which may have their source at the first filter, and the ruby glass film serving to filter out rays in the visible band having wave lengths shorter than that of red rays.

5. A radiant energy lamp for radiating penetrating visible red and short infra-red rays comprising in combination, a light source, a reflector therefor having a reflecting surface of gold, a substantially clear glass filter for filtering out non-penetrating relatively long wave length infra-red rays, a second filter spaced from the first filter and comprising a body of substantially clear glass having on a surface thereof a thin film of ruby glass colored by the introduction of a metal selected from the group consisting of copper and gold, said second filter serving to filter out long wave length infra-red rays which may have their source at the first filter, and the ruby glass film serving to filter out rays in the visible band having wave lengths shorter than that of red rays.

6. A radiant energy lamp for radiating penetrating visible red and short infra-red rays comprising in combination, a shell having an open end, a light source in the shell at its closed end, a reflector in the shell, a substantially clear glass filter in the shell spaced from the light source and spaced from the open end thereof, a second filter substantially at the open end of the shell, said second filter comprising a body of substantially clear glass having a thin film of ruby glass on a surface thereof, the first named filter serving to filter out non-penetrating relatively long wave length infra-red rays, the second filter serving to filter out relatively long wave length infra-red rays which may have their source at the first filter, and the ruby glass film serving to filter out rays in the visible band having wave lengths shorter than that of red rays, said shell having openings therein between the light source and the first filter, and openings therein between the two filters for the passage of air therethrough for cooling the filters.

JAMES H. EASTMAN.

UNITED STATES PATENT OFFICE.

JAMES H. EASTMAN, OF DETROIT, MICHIGAN.

ELECTROTHERAPEUTIC APPARATUS.

1,345,537. Specification of Letters Patent. **Patented July 6, 1920.**

Application filed September 22, 1919. Serial No. 325,353.

To all whom it may concern:

Be it known that I, JAMES H. EASTMAN, a citizen of the United States, residing at Detroit, in the county of Wayne and State of Michigan, have invented certain new and useful Improvements in Electrotherapeutic Apparatus, of which the following is a specification.

This invention relates to electro-therapeutic apparatus, and has for its object a current-regulating screw operating upon the armature. Ordinarily these current-regulating screws change the current flow by varying the pressure between the armature contact and interrupter contact. However, a careless adjustment of this screw may either increase the pressure between the two contacts beyond the power of the armature to break or jam the armature block against the pole piece, causing the apparatus to cease to function as an interrupter. Thereupon a large current flow will be permitted through the magnet coil and will burn it out.

The present invention is an improvement in the regulating screw and its connections so that the regulating screw is entirely independent of the circuit through the magnet coil. The maximum pressure that the magnet has to overcome in breaking a circuit is constant and may be fixed by the manufacturer. The regulating screw operates simply to weaken that pressure and regulate the current flow. If this screw is carelessly adjusted to place too great a resistance in the circuit, the only result is the complete rupture of the circuit and the complete cessation of the current.

A further important advantage is that with my invention the gap between the armature block and magnet pole remains always constant. It can be carefully fixed by the manufacturer to secure the best tractile results from the magnet and can never thereafter be varied by adjusting the screw. These and other objects will be better understood when the invention is described in detail.

In the drawings,—

Figure 1 is a section of the box containing the interrupter and the condenser of a "violet ray" machine.

Fig. 2 is a section on the line 2—2 of Fig. 1.

Fig. 3 is a diagrammatic view of the apparatus.

The so-called "violet ray" machine is used for electro-therapeutic purposes. It comprises usually a magnet coil *a*, an armature *b*, an armature contact *c*, an interrupter contact *d*, a condenser *e*, a transformer *f*, an electrode-holder *g*, and an electrode *x*. The cable *h* is connected up with an electric light socket (not shown) which forms a source of current. This cable contains the two usual conductors, one conductor *i* connecting directly with the magnet coil, the other conductor *k* connecting with the binding post *j* that is in contact with the armature *b*. Hence part of a circuit can be traced through the magnet coil, thence through the connecting wire *l*, and the binding post *m*, which is in electrical connection with the bracket *n* which carries the interrupter contact *d*.

Bridged across the interrupter gap is the condenser *e* and the primary coil of the transformer *f*. The wire *o* leads from the binding post *j* of the armature to the condenser *e*, and the wire *p* leads from the condenser to the primary coil of the transformer, which is shown only in the diagrammatic view and which is supported on the end of the cable *q* (shown in Fig. 1) together with the electrode-holder *g*. From the primary coil of the transformer a wire *r* leads back to the binding post *m* and through the binding post to the interrupter contact *d*. The interrupter alternately makes and breaks the main circuit. The condenser being bridged across the gap causes the current to surge back and forth across the gap, producing a current of increased voltage and high frequency. The transformer *f* which is a step-up transformer, very materially increases the voltage. The result is a current of very high frequency and high voltage in the secondary circuit of the transformer. One end of the secondary circuit *s* of the transformer is grounded by connecting it with the wire *p* of the primary circuit. The other end of the secondary circuit is connected to the electrode-holder *g*. This is ordinarily connected with the glass vacuum electrode *x*. This electrode when placed in contact with the body discharges numerous sparks between the electrode and the body, which gives it its name—"violet ray" apparatus. This much of the apparatus is old.

Heretofore the interrupter contact *d* has been in the form of a screw which can be turned farther in to increase the pressure between the armature contact *c* and the interrupter contact *d* and increase the amount of current by decreasing the resistance, or turned farther out to lessen the pressure of the armature contact *c* upon the interrupter contact *d* and decrease the amount of current. The trouble with this form of adjustment is that if the screw is turned in too far the armature *b* will be jammed up against the magnet pole *t*. The magnet and armature will then cease to function as an interrupter. A continuous current will then flow around the magnet and burn the magnet out. In fact, this adjustment of the current-regulating screw does not have to be such as to jam the armature block against the pole of a magnet. If the current-regulating screw is turned far enough in to bend the armature so that its pressure against the interrupter contact is great, then the strength of the magnet will not be sufficient to attract the armature and there will be no breaking of the circuit. A continuous current will flow around the magnet, the resistance of the coils heating up the wire, and the windings will burn out in short order. These are very serious conditions in apparatus of this kind, which do not occur in an ordinary interrupter, for the ordinary interrupter contact screw is not used as a screw to vary the amount of the current flowing through the apparatus but is given a permanent adjustment usually with the jam nut, with very little likelihood of its getting out of this adjustment. In electro-therapeutic apparatus the pressure of the armature upon the contact is used as a means of regulating the current flow and consequently the position of this screw is being constantly varied by the patient or the operator.

It is the object of the present invention to make the possibility of a continuous flow of current through the magnet practically impossible and insure against burning out notwithstanding the adjustment of the pressure of the armature upon the interrupter contact is used as a regulating means for adjusting the current flow. It is a further object to always have a uniform gap between the armature block and the pole of the magnet. With the current regulating accomplished by the interrupter contact screw, as heretofore, obviously every time the pressure of the armature upon the screw is adjusted the gap between the magnet and armature block is varied.

Instead of an adjustable interrupter contact a stationary contact *d* is provided, the gap between the armature block *y* and the pole *t* always remaining constant. The pressure of the armature upon the interrupter contact *d* is varied by providing an arm *u* that is attached to the armature at right angles thereto between the point where the armature contacts the pole *t* and the point where the armature is supported. Through the top of the box is threaded an adjusting screw *v*, the end of which can engage against this arm *u*. No matter how far this screw *v* is screwed in, a continuous current will not flow through the magnet, for if the armature is jammed up against the end of the pole *t* so that the devices cease to function as an interrupter, then the circuit through the armature and interrupter contact *d* is broken. If the adjusting screw *d* is screwed out of the box until out of contact with the arm *u*, then the pressure between the armature and the interrupter contact is at its maximum, but the armature continues to function as an interrupter so no continuous current around the magnet is possible and the magnet cannot be burned out.

A very material advantage of this improvement is that, as already explained, the gap between the armature block and pole piece always remains constant, and further, the maximum pressure can be established by the manufacturer and can never be varied by adjustment. Hence the manufacturer may set the armature and the interrupter contact in such a position that the maximum pressure will never be greater than is possible for the magnet to break the contact. Hence the apparatus can never cease to function by reason of improper adjustment and burn out the coil. The only error in adjustment that can happen is the screwing of the current-regulating screw to a point where the armature ceases to contact with the interrupter contact. Then the effect is simply to permanently break the circuit and stop all current flow.

The arm *u* affords the additional function of steadying the armature. It has a definite period of vibration, while the armature ordinarily does not. The two being constrained by their connection to move together, this definite period of vibration is in a large measure impressed upon the armature so that the periods of vibration of the armature are more nearly uniform than would otherwise be the case.

What I claim is:

1. In electro-therapeutic apparatus, the combination of a magnet coil, an armature intermittently attracted thereby, an interrupter contact engaged intermittently by the armature, all said devices being in circuit, an arm secured to the armature between its point of support and the interrupter contact, and means for increasing the pressure against the arm to varyingly weaken the pressure of the armature against the interrupter contact.

2. In electro-therapeutic apparatus, the combination of a magnet coil, an armature intermittently attracted thereby, an interrupter contact with which the armature

intermittently engages, all said devices being in circuit, an arm secured to the armature at an angle thereto and between the armature point of support and the interrupter contact, and a screw for increasing the pressure on the arm to varyingly weaken the pressure of the armature against the interrupter contact.

3. In electro-therapeutic apparatus, a magnet coil, a spring armature intermittently attracted by the magnet, an interrupter contact adapted to be intermittently engaged by the armature, all said devices being in circuit, and adjustable means independent of the said circuit for increasing the pressure against only one side of the armature between the point of support and the interrupter contact to varyingly weaken the maximum natural spring pressure of the armature upon the contact.

4. In electro-therapeutic apparatus, the combination of a magnet coil, a spring armature adapted to be intermittently attracted by the magnet, an interrupter contact intermittently engaged by the armature, all said devices being in circuit, an arm secured to the armature between its support and the interrupter contact, and means independent of said circuit for increasing the pressure against only one side of the said arm to varyingly weaken the maximum natural spring pressure between the armature and the interrupter contact.

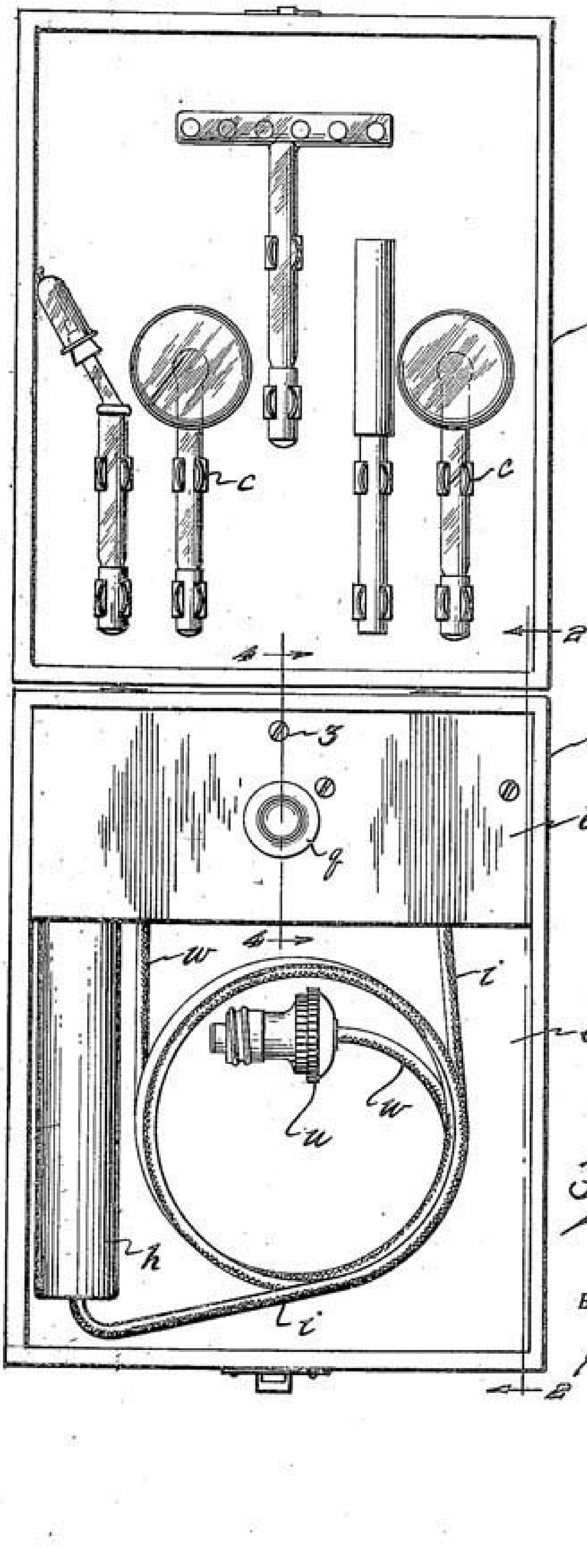
In testimony whereof I affix my signature.

JAMES H. EASTMAN.

J. H. EASTMAN.
ELECTROTHERAPEUTIC APPARATUS.
APPLICATION FILED DEC. 8, 1921.

1,435,055.

Patented Nov. 7, 1922.
2 SHEETS—SHEET 1.



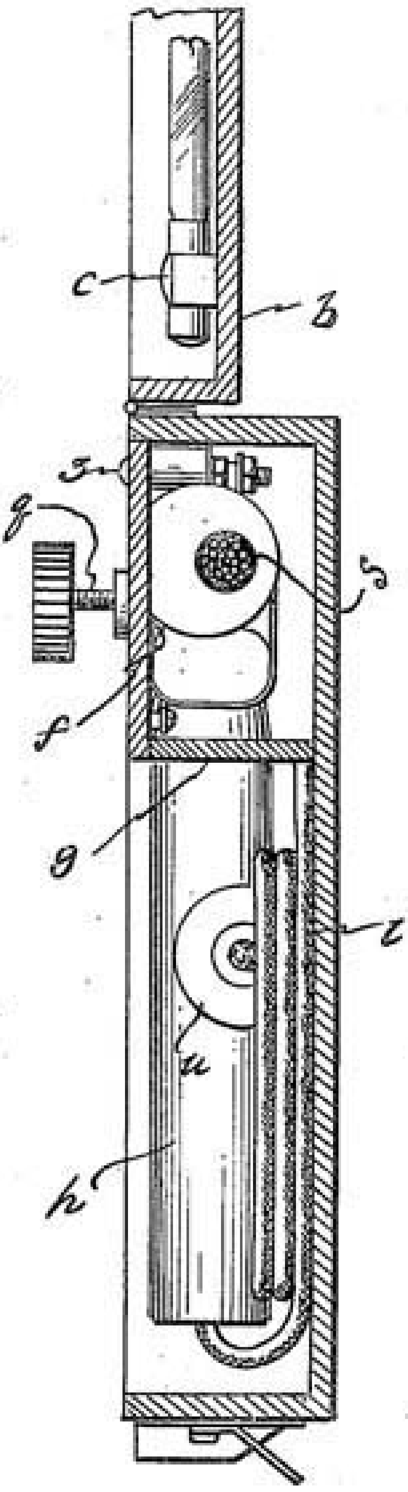


Fig. 2

Fig. 1

INVENTOR.
James H. Eastman

BY
Stuart C. Barnes
ATTORNEY.

J. H. EASTMAN.

ELECTROTHERAPEUTIC APPARATUS.

APPLICATION FILED DEC. 8, 1921.

1,435,055.

Patented Nov. 7, 1922.

2 SHEETS—SHEET 2.

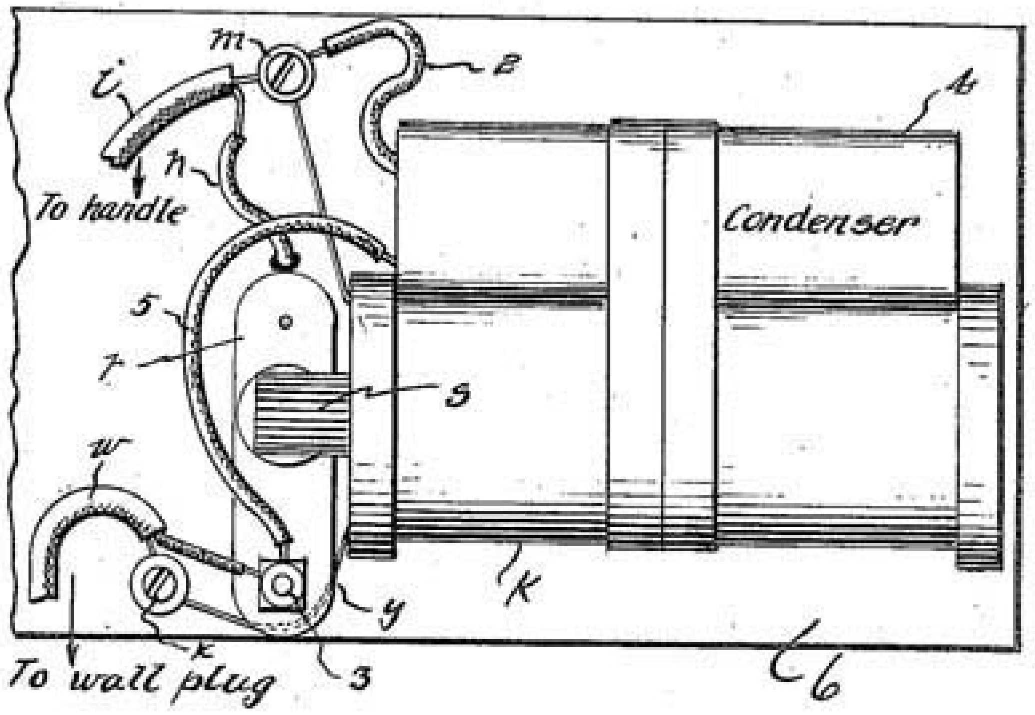


Fig. 3

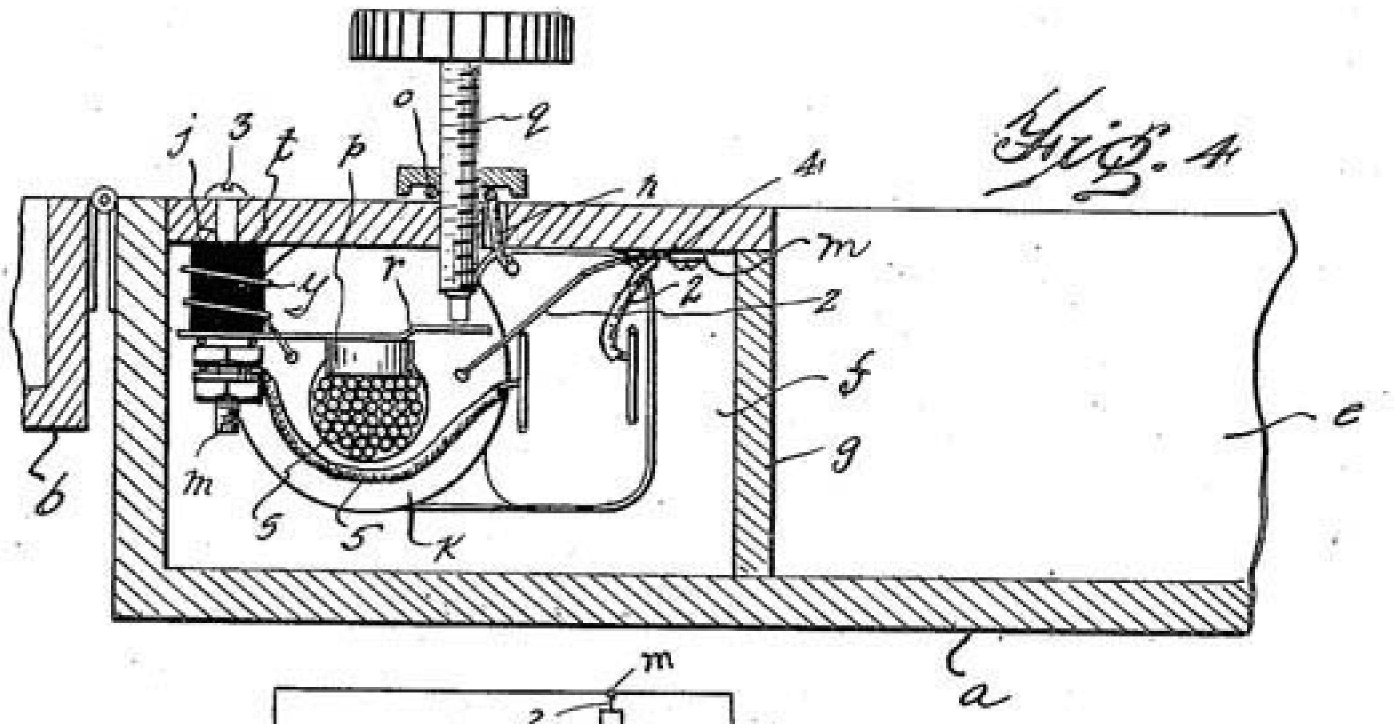


Fig. 4

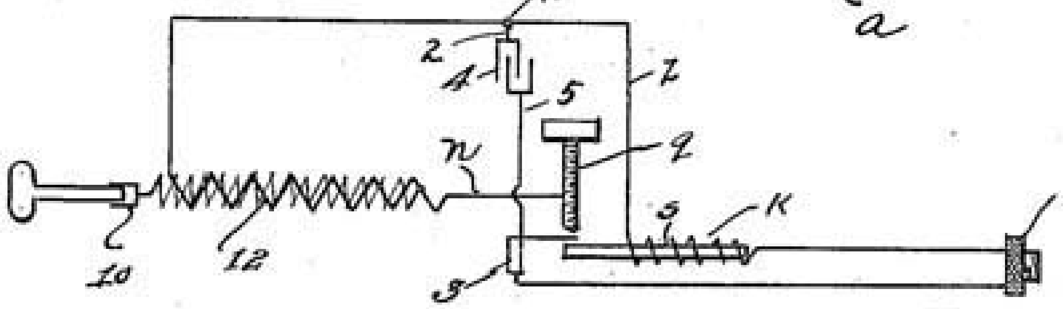


Fig. 5

INVENTOR.

James H. Eastman

BY

Stuart C Barnes

ATTORNEY.

Patented Nov. 7, 1922. **1,435,055**

UNITED STATES PATENT OFFICE.

JAMES H. EASTMAN, OF DETROIT, MICHIGAN.

ELECTROTHERAPEUTIC APPARATUS.

Application filed December 8, 1921. Serial No. 520,835.

To all whom it may concern:

Be it known that I, James H. Eastman, a citizen of the United States, residing at Detroit, in the county of Wayne and State of Michigan, have invented certain new and useful Improvements in Electrotherapeutic Apparatus, of which the following is a specification.

This invention relates to so-called "violet ray" machines or electrotherapeutic apparatus. It is the object of the present invention to provide a machine of this character which has a special arrangement of the vibrator and the adjusting screw in connection with the case which carries the electrodes and the handle. It is desirable to embody the vibrator including its coil and the condenser in a compartment of the case, the electrodes, the electrode handle and the cord also being arranged in the case about the compartment containing the vibrator and condenser.

My improvement resides in the arrangement of the magnet coil, armature and adjusting screw for the interrupter gap in such a way that the same may be contained in a relatively shallow compartment, yet at the same time the adjusting screw will protrude through the top of the compartment in a convenient place for manipulation. The arrangement that I have designed is such that it requires no additional fixture or motion-converting devices to permit a right angular disposition of the adjusting screw with respect to the axis of the coil, as will presently be explained.

In the drawings.—

Fig. 1 is a plan view of the case showing the cover open.

Fig. 2 is a section on the line 2—2 of Fig. 1.

Fig. 3 is a view of the under side of the cover of the apparatus compartment.

Fig. 4 is a section on the line 4—4 of Fig. 1.

Fig. 5 is a diagram of the wiring.

The case is simply a shallow, square or rectangular case having a body *a* and a cover *b*. The cover *b* has on its inside suitable clips *c* which hold a variety of glass vacuum electrodes and metal electrodes. The heads of these electrodes project above the cover and fit into the chamber *e* of the body of the case. *f* designates an apparatus compartment which is divided off from the chamber *e* by the partition *g*. This apparatus compartment takes a portion of the electrode handle *h* which contains the induction coil. This coil contains a suitable primary circuit and a suitable secondary circuit, one end of which engages the electrode socket 10 and the other end of which is grounded in the primary. This is all common construction with apparatus of this kind.

The primary circuit runs through the insulated cord *i* to the apparatus compartment, as shown in Fig. 3, and then one lead runs off to the binding post *m*. The other lead, designated *n*, leads to the nut *o* through which screws the adjusting screw *q*. The end of this adjusting screw *q* forms one terminal of the interrupter gap and the other terminal is the armature arm *r* which carries the armature *p*. The magnet coil *k* has a core *s* made up of a bundle of wires which extend clear beyond the winding to form a core extension which is leveled off on its upper side to form a seat for the armature *p* secured to the armature arm *r*. This armature arm supported upon the post *j* is provided with an insulating sleeve *t*.

The wall plug is designated *u* and connects with the cord *w* which enters the left hand side of the apparatus compartment (Fig. 1) and has one lead *y* secured to the binding post *x* and then wound around the insulated sleeve *t* and from thence running into the magnet coil *k*. The other end of the magnet coil connects by the lead *z* with the post *m*. The condenser is hooked up to the binding post *m* by the lead 2.

From the above description it will be evident that the "hook up" shown in Fig. 5, diagrammatically, is had, namely, one side of the service line runs to the magnet coil *k*, the other side connects directly with the armature post 3. The primary 12 of the induction coil has one end connected with the adjusting screw *q* and the other end connected with the condenser 4. The other side of the condenser connects by the lead 5 with the armature post 3. It will, therefore, be seen that the service line leads directly through the primary of the induction coil, across the interrupter gap, and thence back to the wall plug. The condenser is bridged across the interrupter gap and the primary of the induction coil is in circuit with the condenser.

The armature post 3 is suspended from the lid or cover 6 of the apparatus compartment. This post carries the armature arm *r* that carries the armature *p*, which engages the flattened surface of the core extension *s*. This permits the adjusting screw *q*, which is one of the contacts of the interrupter, to extend vertically (when the case is set down in flat position) through the apparatus compartment lid, where it is handy for adjustment. It will be evident that this grouping of the various elements permits the magnet coil and the condenser to be laid out the long way in the apparatus box and at the same time the adjusting screw protrudes vertically through the lid of the box at right angles to the axis of the magnet coil. It has heretofore been proposed to lay the magnet coil lengthwise of the apparatus compartment but it has been necessary to either have the adjusting screw lie in the same direction within the compartment or else use a different interrupter terminal which connects with the adjusting screw by virtue of some motion-converting device. That is, the adjusting screw is extended vertically through the top of the lid but the armature lying on its side has to have a separate interrupter device connected to the screw by some motion-converting devices, such as a worm and gear or some similar device, requiring suitable bearings, hangers, etc., which make the construction complicated and costly. This is all done away with by my arrangement.

What I claim is:

1. In electrotherapeutic apparatus, the combination of a case provided with an apparatus compartment including a cover, a magnet coil supported with its axis parallel to the said cover and provided with a core having an extension beyond the end of the coil, an armature and armature arm functioning at right angles to the axis of said magnet coil, the armature adapted to bear against the side of the core extension, and an adjusting screw for the interrupter gap running through said cover at right angles to the axis of the magnet core.

2. In electrotherapeutic apparatus, the combination of a case provided with a shallow apparatus compartment having a removable lid, a magnet coil and core supported on the under side of said lid with the magnet having its axis running parallel with said lid, a core provided with an extension beyond the end of the coil, an armature post suspended from the armature lid, an armature arm supported at one end thereby, an armature supported on such arm and functioning at right angles to the axis of the coil and adapted to abut against the side of the core extension, and an adjusting screw for the interrupter gap running through the said lid and having its end forming one terminal interrupter gap while the other terminal of the interrupter gap is formed by the armature arm.

3. In electrotherapeutic apparatus, the combination of a magnet coil and core, a core provided with an extension extending beyond the end of the coil and provided with an armature seat, an armature functioning at right angles to the axis of the coil and adapted to abut against the seat at the side of the core extension, and an adjusting screw for the interrupter gap disposed at right angles with respect to the axis of the core and having at its end an interrupter gap terminal, the other interrupter gap terminal being afforded by the end of the armature arm.

In testimony whereof I affix my signature.

JAMES H. EASTMAN.

Jan. 13, 1925

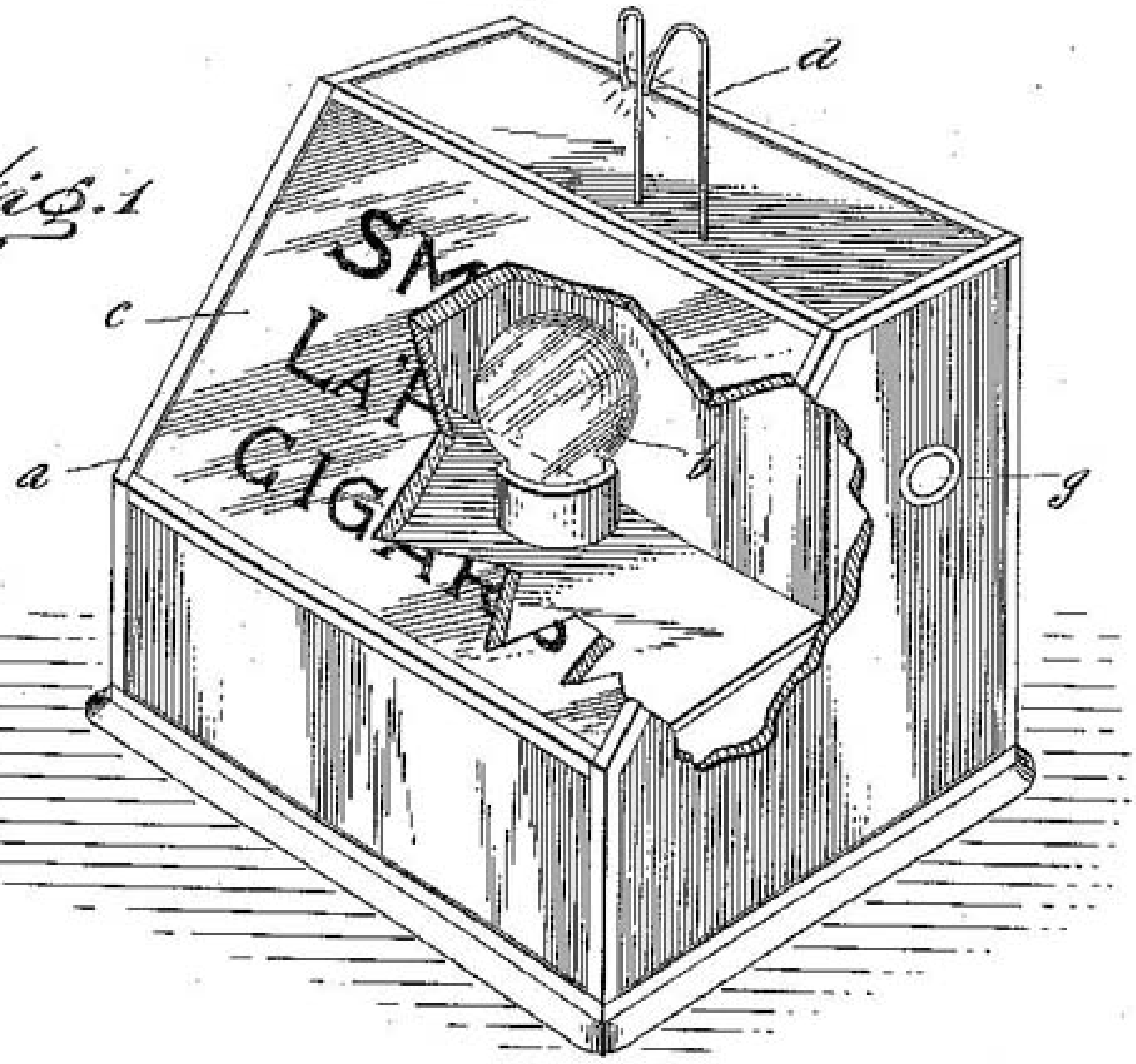
1,523,107

J. H. EASTMAN

CIGAR LIGHTER

Filed Feb. 15, 1922

Fig. 1



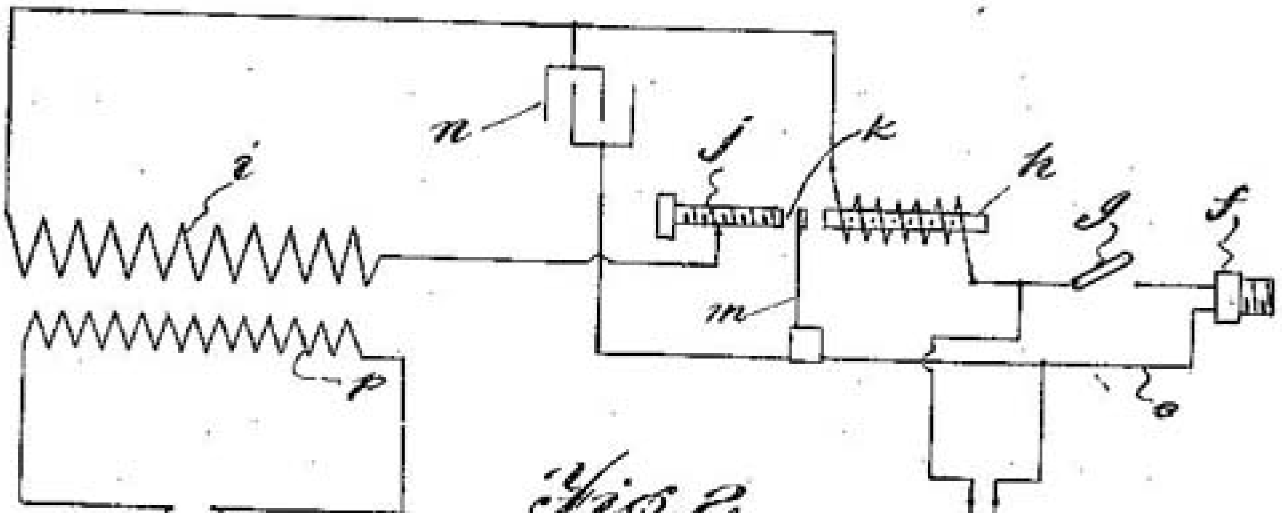


Fig. 2

Inventor

James H. Eastman.

By Stuart C. Barnes

Attorney

Patented Jan. 13, 1925. **1,523,107**

UNITED STATES PATENT OFFICE.

JAMES H. EASTMAN, OF DETROIT, MICHIGAN.

CIGAR LIGHTER.

Application filed February 15, 1922. Serial No. 536,640.

To all whom it may concern:

Be it known that I, JAMES H. EASTMAN, a citizen of the United States, residing at Detroit, in the county of Wayne and State of Michigan, have invented certain new and useful Improvements in Cigar Lighters, of which the following is a specification.

This invention relates to cigar lighters and especially to a combined cigar lighter and advertising device. It has for its object a cigar lighter which uses a discharge of harmless electric sparks to ignite the cigar. At the same time this discharge takes place an electric light flashes and draws attention to advertising matter.

In the drawings,—

Fig. 1 is a perspective of the device, with parts broken away.

Fig. 2 is a diagrammatic view of the wiring.

a designates a case which, of course, can be of any description. Within this case is located an electric lamp *b* behind a glass *c*, on which is inscribed an advertising legend. This glass is in the front of the case directly before whoever desires to use the cigar lighter. The cigar lighter comprises a pair of terminals *d* which have their outer ends turned down so that they can be used to light a pipe as well as a cigar. These terminals are spaced apart some distance as shown in the drawing.

It is the object of the present invention to provide a discharge of sparks generated by a high frequency and high voltage current. Such a current is harmless if the person using the igniter accidently gets a shock, as the same character of current is used in electrotherapeutic apparatus. At the same time the arc formed by this current will leap a very considerable gap and will ignite anything combustible that is held in its path.

The wall plug is designated *f*. The primary circuit is designated *e* and extends from the wall plug through the switch *g*, is coiled about the magnet core *h* and then passes to the primary winding *i* of the induction coil, thence back to the vibrator screw *j*, across the interrupter gap *k* to the armature *m* and back to the wall plug.

In parallel with this circuit is the incandescent lamp *b*. A condenser *n* is bridged across the interrupter gap *k*, hence when the push button switch *g* is closed, the current from the ordinary 110 volt circuit passes around the magnet core *h*, attracting the armature *m*, and consequently breaking the circuit and causing a continuous vibration by this make and break. This making and breaking of the current builds up the electrical charges in the condenser and when the circuit is open the current surges across the interrupter gap, producing an oscillating current of very high frequency passing through the primary winding *i* of the induction coil. This is transformed into a high frequency, high voltage current by the secondary winding *p* of the induction coil.

The two terminals *d*, *d* afford a gap in this secondary circuit through which this high frequency, high voltage current will leap by reason of its high potential, anywhere from 50,000 to 75,000 volts if the windings are given the appropriate number of turns. The frequency of a current of this character is enormous; in fact, probably anywhere from 100,000 to 1,000,000 per second.

This arrangement provides a hot but harmless spark. It can be used as a direct igniting means when coupled up with an ordinary lighting circuit. At the same time the push button switch *g* can be utilized to light the incandescent bulb filament. Hence the same switch coincidentally illumines the advertising sign and turns on the spark by which the person addressing the case may ignite his cigar, cigarette or pipe.

What I claim is:

In a cigar lighter, the combination of a support, a pair of electrical terminals supported upon the same in spaced relation to permit the exposure of a cigar to the line of sparks passing continuously from terminal to terminal, means within the support for transforming an ordinary lighting circuit current into a relatively very high potential, high frequency current, and means for conducting said current to the terminals, said two last mentioned means including a switch remote from the terminal which may be held closed to cause a continuous line of sparks to pass between the terminals and ignite the cigar.

In testimony whereof I affix my signature.

JAMES H. EASTMAN.

Nov. 30, 1926.

J. H. EASTMAN

1,609,243

ELECTROTHERAPEUTIC ELECTRODE

Filed Dec. 19, 1924

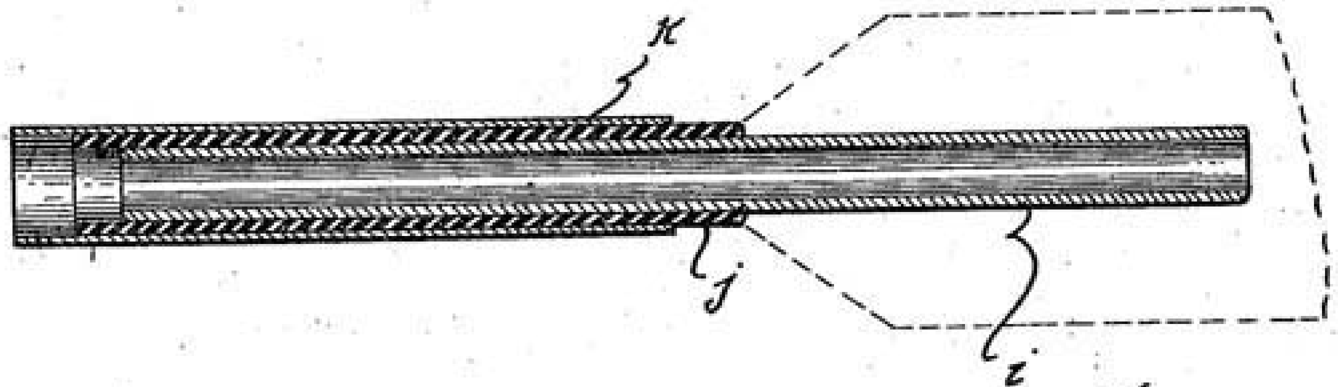


Fig. 1

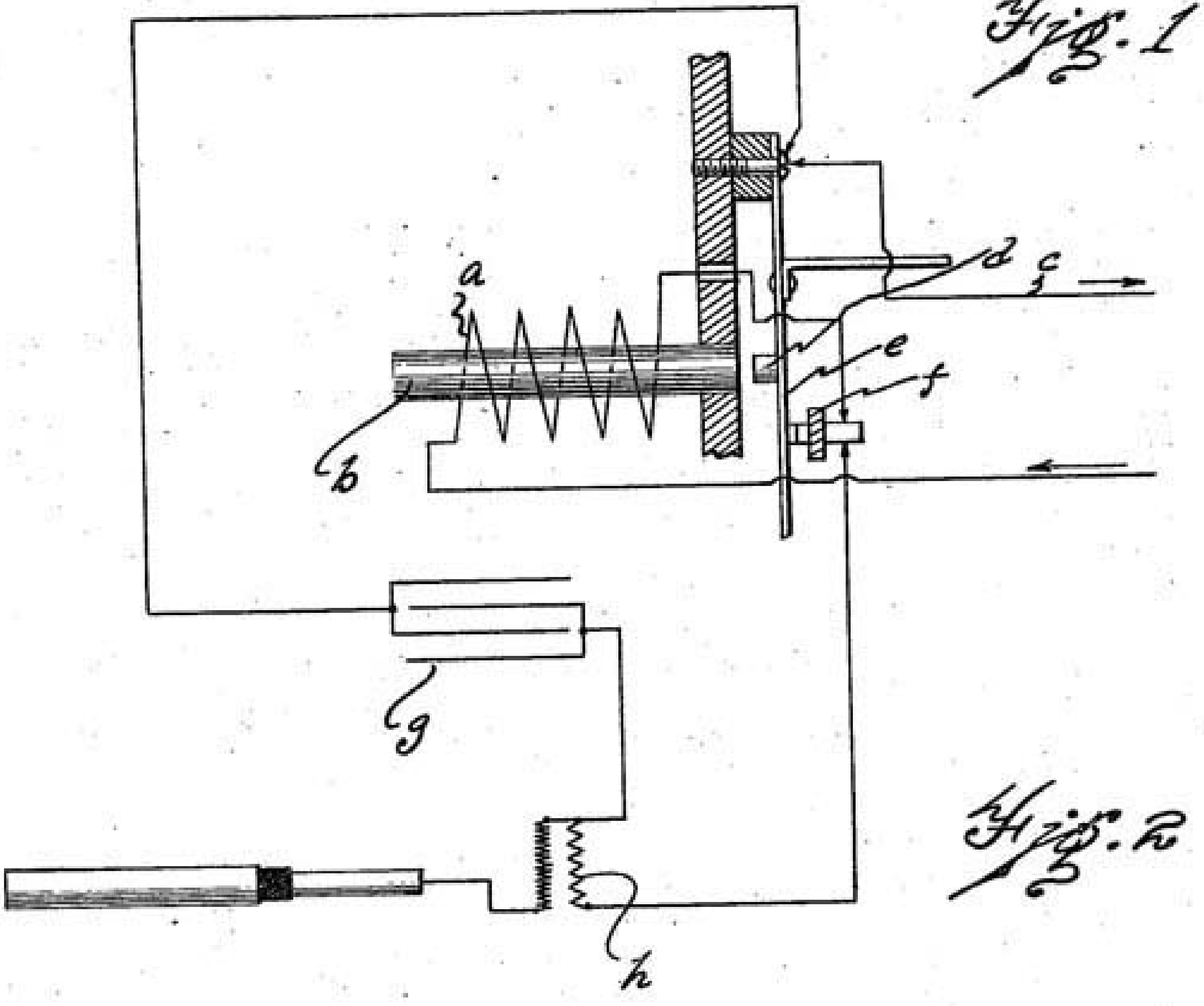


Fig. 2

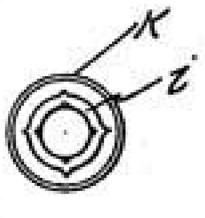


Fig. 3

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BY Stuart C. Barnes
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Patented Nov. 30, 1926. **1,609,243**

UNITED STATES PATENT OFFICE.

JAMES H. EASTMAN, OF DETROIT, MICHIGAN.

ELECTROTHERAPEUTIC ELECTRODE.

Application filed December 19, 1924. Serial No. 757,049.

This invention relates to electrotherapeutic apparatus. In high frequency or violet ray apparatus used for electro-therapeutic purposes it is common to use two varieties of electrodes, namely, vacuum glass tubes and metal electrodes. In monopolar machines it is found desirable, if not necessary, to connect the secondary of the induction coil to the primary coil.

No bad effects follow from this unless the patient using a metal electrode becomes grounded. If he happens to touch a bathroom fixture, a radiator coil, or any other direct communication with the ground he will get a terrific shock. The reason for this is that he is in direct circuit with the lighting circuit and consequently gets all the current flowing through the light circuit plus the addition of voltage impressed upon it by the coils in the high frequency apparatus.

It is the object of the present invention to overcome this objection by making the electrode in the form of a condenser.

In the drawings:

Fig. 1 is a longitudinal section of my improved condenser.

Fig. 2 is a diagrammatic view of the apparatus.

Fig. 3 is an end elevation of the electrode.

In an apparatus of this kind the hook-up usually comprises an inductance or kicking coil *a* having an iron core *b*. This is connected up with an electric light circuit *c*. When the current flows through the coil *a* the core is energized and magnetized, attracting the armature *d* of the interrupter arm *e*. This breaks the circuit at the point *f*. The condenser *g* is bridged across the interrupter gap and when the circuit is broken the condenser rapidly charges and discharges across the gap furnishing oscillations of high frequency and a relatively high voltage. This voltage is again stepped up to an even higher voltage by means of the induction coil *h*. The secondary of this induction coil is connected with the primary as shown in the drawings. The other end of the secondary is connected with the socket in which the electrode, either a plain metal electrode or a glass vacuum tube, can be interchangeably fitted.

My improvement consists of a new form of metal electrode instead of a plain metal electrode. I use the electrode having a metal tube *i*, a dielectric sleeve *j* and a metal shell *k*. These are connected together by swaging the inner tube *i* with an instrument when they have been fitted together, as shown in Fig. 3. This distorts the shape of the inner tube so as to tie the parts together.

This dielectric is preferably fibre, which is a good dielectric in the sense that it readily permits the passage of electrostatic induction but is an insulator of high value to the direct passage of an electric current. This, therefore, protects the user by completely insulating him from a direct connection with the electric light circuit. On the other hand, it furnishes a condenser of sufficient capacity for electrostatic induction, that is to say, it furnishes a condenser with two metal plates with interposed dielectric as the inner plate is alternately charged at an enormous frequency with positive and negative electricity. This alternately repels and attracts and causes the current to flow into and flow from the patient's body.

What I claim is:

1. A high frequency electrode for electrotherapeutic apparatus, comprising a pair of metal members separated by a dielectric only the outer metal member being adapted to contact with the body of the patient

2. A high frequency electrode for electrotherapeutic apparatus, comprising a metal member adapted to be connected to the socket of the apparatus, a second metal member for contacting with the body of the patient and enclosing said first-named metal member, and a dielectric material separating said two metal members.

3. A high frequency electrode for electrotherapeutic apparatus, comprising a metal tube for fitting into a socket, a dielectric sleeve fitted around the tube and a member in the form of a condenser plate for the hand to grasp.

4. A high frequency electrode for electrotherapeutic apparatus, comprising a metal tube for fitting into a socket, a dielectric sleeve of distortable material covering the outer surface of the metal tube, and a metal shell on the outside of the sleeve, the inner sleeve being swaged to tie the members together.

In testimony whereof I have affixed my signature.

JAMES H. EASTMAN.

April 26, 1927. **1,626,030**

J. H. EASTMAN

SPARK GAP DEVICE

Filed May 17, 1926

Fig. 1.

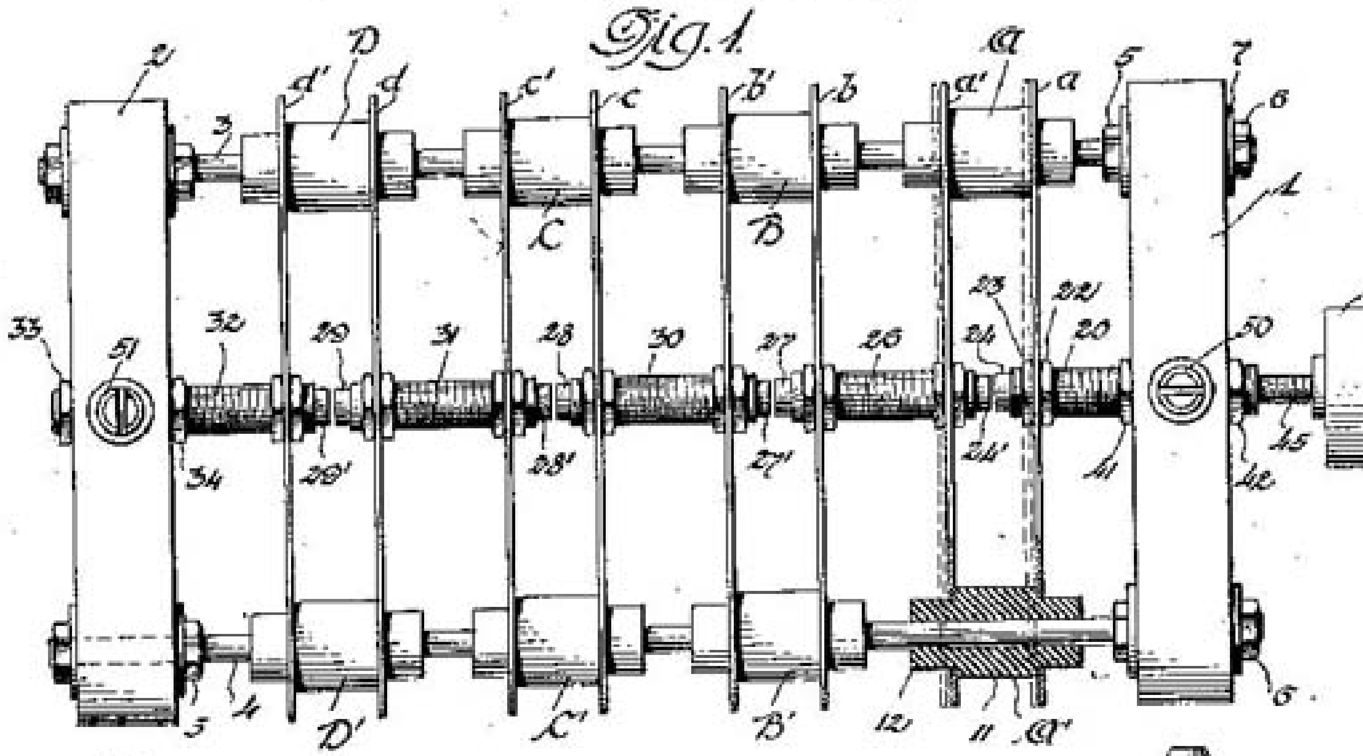


Fig. 2.

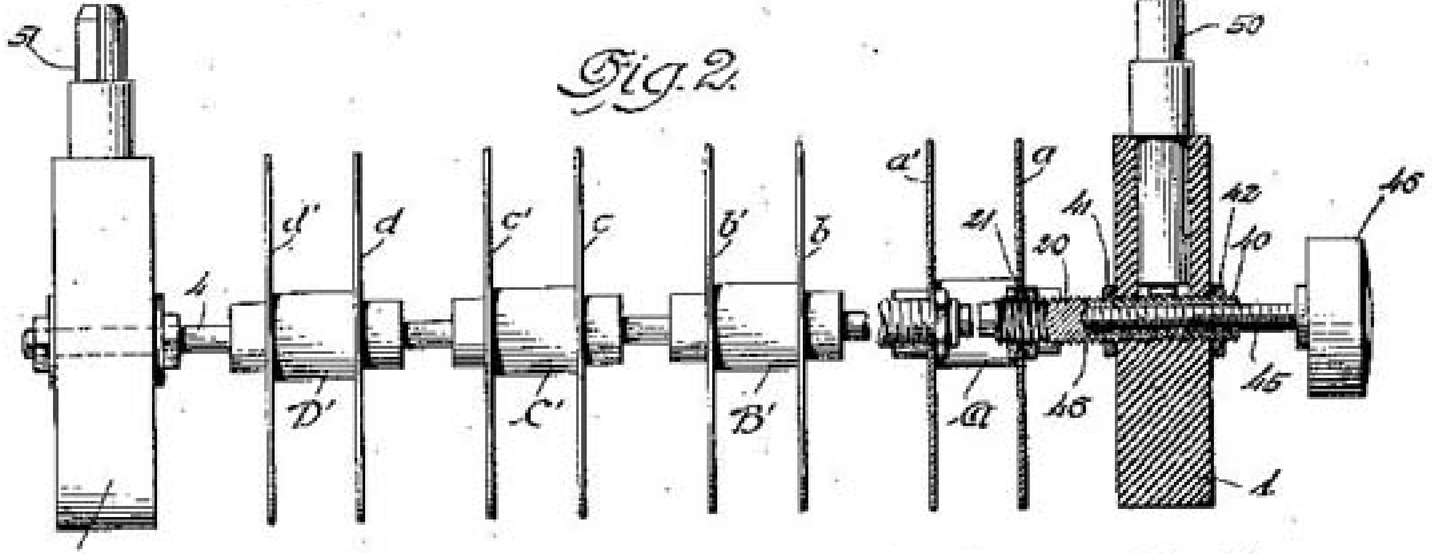


Fig. 3.

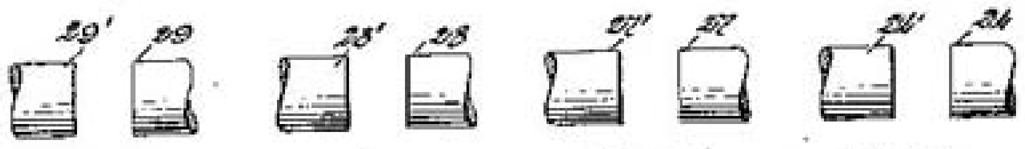


Fig. 4.

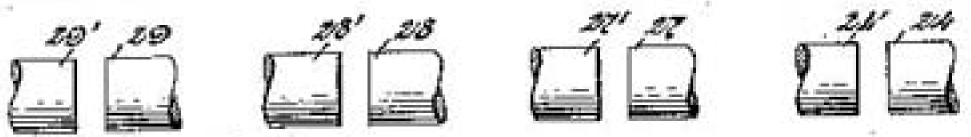
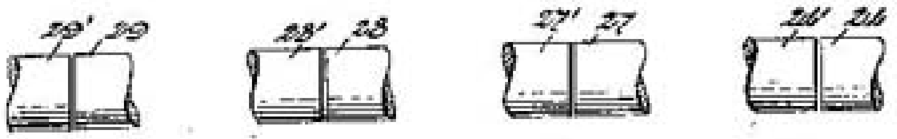


Fig. 5.



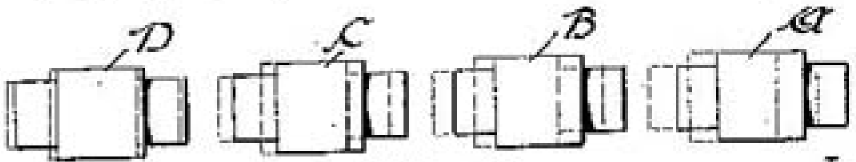


Fig. 6.

INVENTOR:
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BY Stuart C Barnes
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Patented Apr. 26, 1927. **1,626,030**

UNITED STATES PATENT OFFICE.

JAMES H. EASTMAN, OF DETROIT, MICHIGAN.

SPARK-GAP DEVICE.

Application filed May 17, 1926. Serial No. 109,907.

This invention relates to electric spark gap devices and has to do more particularly with such a device adapted for use in high frequency apparatus used for electro-therapeutic purposes.

In an apparatus of the character referred to the adjustment of the spark gap must be accurately made and maintained in order to obtain the best results. This is especially true when more than one spark gap is used and difficulty has been experienced in adjusting all the spark gaps so that the apparatus operates in a proper manner.

In accordance with the invention the adjustment between the electrodes of a spark gap can be easily and accurately made, and such adjustment once made, will be maintained. The construction of the device is such that a plurality of gaps may be used, and adjustment of any one gap may be made independently of the other gaps, and further adjustment may be made which affects all of the gaps. The construction may be such as to afford for radiation of heat generated in the use of the device.

In a satisfactory form of the invention a frame is provided, and upon this frame are mounted a plurality of electrodes arranged in pairs, each pair providing a spark gap. These electrodes are carried by interconnected supports, and an adjusting device is provided which acts upon the supports, affords simultaneous adjustment of all the spark gaps, and the supports may include members which radiate heat generated by the spark gaps while in use. Also, each electrode is mounted on its respective support so that each spark gap may be more or less permanently adjusted independently of the other spark gaps.

In the accompanying drawings:

Fig. 1 is a plan view of the device showing one portion in section.

Fig. 2 is in part a side elevation, and in part a sectional view.

Figs. 3, 4 and 5 are enlarged diagrammatical views showing the manner in which the electrodes move during adjustment.

Fig. 6 is a diagrammatical view showing in a magnified manner the movements of members which assist in supporting the electrodes.

Referring to the drawings, and particularly to Fig. 1, the device is shown as comprising a frame having end pieces 1 and 2 which are preferably of insulating material. These end pieces are connected by rods 3 and 4, the rods being securely fastened to the end pieces by nuts 5 and 6, there being, if desired, a washer 7, placed between each nut and the end pieces.

Slidably mounted upon the rod 3 are spool-like members A, B, C and D of insulating material which have an enlarged central portion 11 and reduced ends 12. Similar members A′, B′, C′ and D′ are mounted upon the rod 4. These spool-like members carry plates, the plates having holes therein which more or less loosely fit over the reduced ends 12 of the spools. The enlarged central portion of the spools serve to space the two plates carried thereby. These plates are arranged in pairs, one pair, plates *a* and *a′* being carried by the spools A and A′, and the other pairs being similarly carried by the other spools.

Each pair of plates support the terminals of a spark gap. The plate *a*, carries a threaded member 20 which extends through an aperture 21 in the plate. Nuts 22 and 23 are screwed onto member 20 and tightened against the plate to thus hold the member 20 fixed with relation to the plate. One end of the member 20 forms a terminal 24, and this end of the member may be of any material suitable for the purpose. Plate *a′* supports a terminal 24′ spaced from the terminal 24. This terminal 24′ is one end of a member 26, which extends through an aperture in the plate *a′* and is fixed to the plate by lock nuts similar to the manner in which the member 20 is fixed to the plate *a*. This member 26 is not only fixed to the plate *a′* but also extends through the plate *b* and lock nuts secure the member to the plate *b*. The end of the member 26 which protrudes through the plate *b* provides a terminal 27.

A member 30, similar to the member 26, is secured to plates *b′* and plate *c*, and this member provides terminals 27′ and 28. A member 31 similar to the members 27 and 30 connects plates *c′* and *d*, and provides spark terminals 28′ and 29. A terminal 29′ opposes terminal 29, and this terminal is provided on the end of a member 32 which extends through the end piece 2 and is secured thereto by nuts 33 and 34. This member 32 extends through an opening in the plate *d′* and lock nuts fix the member to this plate similarly to the manner in which lock nuts secure other terminal carrying members to other plates.

By this construction it will be observed that a spark gap is positioned between the plates which are carried by the spool members, and that each pair of plates are centrally connected by the rigid members 26, 30 and 31 to the next adjacent pair. The distance between the spark gaps may be adjusted more or less permanently by the adjustment of the nuts which fix the spark terminal carrying members to the plates. For example, the distance between the spark terminals 27 and 27′ is adjustable by the adjustment of the lock nuts which fix the members 26 and 30 to the plates *b* and *b′* respectively, and in a like manner each of the other spark gaps are adjustable. Owing to the fact that the members 26, 30 and 31 are rigid the adjustment is made by a slight flexing or bending of the plate members which is permitted by the loose connection between the plates and their respective spools.

In addition to this more or less permanent adjustment of the spark gaps, which may be made on each spark gap independently of the others, further adjustment is provided which acts on all the spark gaps simultaneously. This adjusting mechanism is shown in section in Fig. 2, and consists of a tubular member 40 which extends through the end piece 1, and is adjustably secured thereto by nuts 41 and 42. Through this tubular member extends a screw member 45 provided with an enlarged head 46 which may be turned by the fingers of the operator. The opposite end of the screw 45 is shaped to fit within the slightly recessed end 46 of the member 20.

Suitable terminals 50 and 51 are provided and these terminals may have a split head as indicated for the purpose of receiving an electrical conductor, or the heads may be of any other desirable construction for this purpose. These terminals extend into the body of the end pieces 1 and 2. The terminal 50 contacts with the tubular member 40 and the terminal 51 contacts with the member 32 so that the spark gaps are connected in series.

In the use of the apparatus the spark gaps are all adjusted so that the distance between each pair is substantially the same. This is accomplished as heretofore set forth by the adjustment of the lock nuts. With the spark gaps thus adjusted the single operation of turning the thumb piece 46 simultaneously adjusts all the spark gaps in an equal degree. By turning the thumb piece 46 so that the screw 45 moves through the tubular member 40 from right to left, Fig. 2, the member 20 is forced away from the tubular member 40. This forcing away of the member 20 acts on the plate *a* and slides the spool members A and A′ which carry this plate from right to left along the rods 3 and 4. This causes the plate *a′* to also move from right to left and this movement is communicated through the rigid member 26 to the plate *b*, the spools B and B′ which carry the plate *b* and thence to the plate *b′*. The plate *b′* moves the rigid member 30 which communicates the motion to plates *c*, *c′* and so on to the last plate *d′*.

This adjustment causes a flexing of each pair of plates towards each other and the spark gap terminals are thus brought closer and closer. This flexing is indicated in Fig. 1 by the dotted lines which show the way plates *a* and *a′* are flexed, it being understood that each pair of plates are similarly flexed. Also as indicated by the dotted lines both plates move from right to left. When the member 20 is forced inwardly it acts on the plate *a* centrally. However, all the rest of the plates resist this action through their central connections. For example, plate *a′* is connected rigidly to plate *b*, and when the adjustment is made plate *b* is flexed inwardly toward plate *b′* but it resists this movement through the rigid member 26, thus causing a like flexing of plate *a′*. It will be understood that all of the plates are of substantially the same elasticity. Also the plates are sufficiently stiff to overcome friction between the spools and rods.

The relative movements of the spool members are diagrammatically shown in Fig. 6. The solid lines indicate the relative position of the spools when the adjustment of the screw 45 permits the member 20 to abut against the member 40. In dotted lines, the relative positions of the spools are indicated after the screw 45 has been adjusted inwardly for a considerable distance. It will be observed that the spool A has moved a considerable distance from right to left and that the movements of the spools B, C and D have diminished progressively.

The peculiar movement of the spark gap which results from this progressively diminishing movement of the spools is indicated in Figs. 3, 4 and 5 respectively. Fig. 3 indicates the relative position of the spark gaps before an adjustment has been made. The distance between each pair of spark terminals is substantially the same. Fig. 4 indicates the relative position of the spark gaps after an adjustment has been made and the distance between each two cooperating terminals has been lessened to an equal degree. The spark gaps per se have been moved from right to left with a progressively diminishing degree of movement similar to the progressively diminishing movements of the spools. However, the relative movements between any two cooperating terminals is the same. The terminal 24 has been moved from right to left toward the terminal 24′, but at the same time the terminal 24′ has receded from its original position but its movement has not been so great and the gap is thus lessened. The terminal 27 has been moved from right to left the same distance as the terminal 24 has receded. The terminal 27′ has receded, but this movement has been less than the movement of the terminal 27 and thus this gap has been lessened. In the same manner, the gap between the terminals between 28 and 28′ have been lessened. The terminal 29′ has remained stationary by reason of its rigid connection to the end piece 2 through the member 32, but the terminal 29 has moved towards the terminal 29′ and thus this gap has been lessened. Thus it will be observed that all of the gaps per se move from right to left, but the relative movement between the terminals 24 and 24′, 27 and 27′, 28 and 28′, 29 and 29′ has been the same.

Fig. 5 shows the position of the terminals after a still further adjustment has been made, and the terminals have been brought quite close together. Here again it will be observed that each gap has moved from right to left, but the degree of movement between each pair of cooperating terminals has been equal.

As heretofore set forth the plates are substantially of the same elasticity. As the screw 45 forces the plate *a* inwardly at its central portion, this movement is opposed by the rigid connection 32 of the plate *d′*. This opposing force is communicated through all of the plates and spools, thus causing an equal flexing of each pair of plates towards each other and resulting in an equal adjustment between each pair of terminals.

The supporting plates are shown as being of such a size as to radiate efficiently the heat which is generated during the use of the device, although they may not be so constructed, but may take the form of strips of material connecting the spools. Should additional radiation of heat be required, plates or fins can be secured to the centrally disposed terminal carrying members such as the member 26. These additional fins or plates could be arranged so as not to connect with the side rods.

What I claim is:

1. A spark gap device comprising a plurality of electrodes arranged in pairs, means for supporting the electrodes including elastic plates, each electrode being mounted in such a way that it can be adjusted relatively to its respective plate, and adjusting means acting upon the plates to flex the same for simultaneously adjusting the spark gaps.

2. A spark gap device comprising a frame having end portions and side portions, a pair of elastic cross members carried by the side portions of the frame, an electrode of a spark gap carried by each cross member and means for flexing the cross members to adjust the spark gap.

3. A spark gap device comprising a frame having end portions and side portion, a pair of elastic cross members slidably carried by the side portions of the frame, an electrode of a spark gap carried by each cross member and means for flexing the cross members to adjust the spark gap.

4. A spark gap device comprising a frame having end portions and side portions, a pair of elastic cross members slidably carried by the side portions of the frame, an electrode of a spark gap carried by each cross member, means for flexing the cross members to adjust the spark gap, and means for adjusting each electrode relative to its respective supporting cross member.

5. A spark gap device comprising a frame having end portions and side portions, a pair of plates bridging the side portions of the frame and slidably carried thereby, an electrode of a spark gap carried by each plate, means for flexing the cross members for adjusting the spark gap and means for adjusting each electrode relative to its respective carrying plate.

6. A spark gap device comprising a frame having end portions and side portions, a plurality of cross members slidably carried by the side portions of the frame, these cross members being arranged in pairs, an electrode of a spark gap carried by each cross member and means for flexing the plates to adjust the spark gaps.

7. A spark gap device comprising a frame having end portions and side portions, a plurality of elastic plates slidably carried by the side portions of the frame, these plates being arranged in pairs, an electrode of a spark gap being carried by each plate and means for flexing the plates to adjust the spark gaps.

8. A spark gap device comprising a frame having end portions and side portions, a plurality of heat radiating plates slidably carried by side portions of the frame, these plates being arranged in pairs, an electrode of a spark gap being carried by each plate, means for adjusting each electrode relative to its respective plate and means for flexing the plates to adjust the spark gaps.

9. A spark gap device comprising a frame having end portions and side portions, a plurality of elastic plates slidably carried by the side portions of the frame, these plates being arranged in pairs, an electrode of the

spark gap being carried by each plate, means for adjusting each spark gap independently and means for flexing the plates to adjust all of the spark gaps simultaneously.

10. A spark gap device comprising a frame having end portions and side portions, a plurality of elastic plates slidably carried by the side portions of the frame, these plates being arranged in pairs, rigid means connecting each pair of plates, an electrode of a spark gap being carried by each plate, means for adjusting each spark gap independently, and means for flexing the plates to adjust the spark gaps simultaneously.

11. A spark gap device comprising a frame having end portions and side portions, a plurality of plates arranged in pairs and carried by the side portions of the frame, each pair of plates being slidable on the side portions, an electrode of a spark gap carried by each plate and means for flexing each pair of plates for adjusting the distance between the electrodes carried thereby.

12. A spark gap device comprising a frame having end portions and side portions, a plurality of plates arranged in pairs and carried by the side portions, each pair of plates being slidable on the side portions and being connected to the next adjacent pair of plates, an electrode of the spark gap carried by each plate and means for flexing each pair of plates for adjusting the distance between the electrodes carried thereby.

13. A spark gap device comprising a frame having end portions and side portions, a plurality of elastic plates arranged in pairs and carried by the side portions of the frame, each pair of plates being slidable on the side portions, an electrode of a spark gap carried by each plate, and means for sliding each pair of plates along the side portions of the frame with a progressively diminishing degree of movement to adjust the several spark gaps.

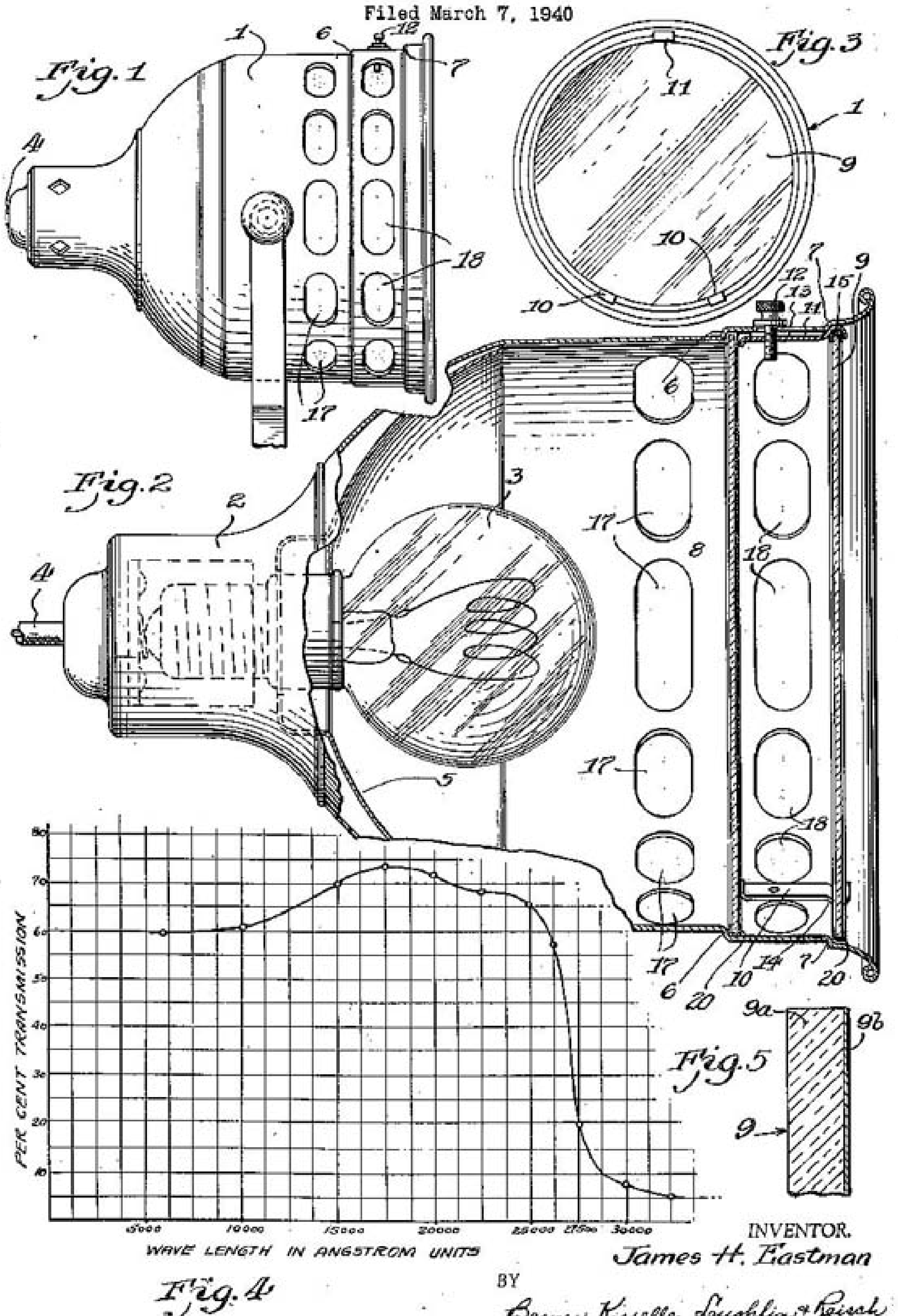
In testimony whereof I affix my signature.

JAMES H. EASTMAN.

March 10, 1942. J. H. EASTMAN **2,275,745**

RADIANT ENERGY LAMP

Filed March 7, 1940



INVENTOR.
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BY
Barnes, Kisselle, Laughlin & Raisch
ATTORNEYS

Patented Mar. 10, 1942 **2,275,745**

UNITED STATES PATENT OFFICE

2,275,745

RADIANT ENERGY LAMP

James H. Eastman, Atlin, British Columbia, Canada

Application March 7, 1940, Serial No. 322,681

6 Claims. (Cl. 250—86)

This invention relates to radiant energy lamps, and it has to do particularly with a lamp for the radiation of rays which will penetrate the tissue below the surface and which is useful for what is sometimes called deep therapy.

The principal object of the invention is the provision of a lamp which is highly effective and efficient in its radiation of rays in the penetrating wave length band for the application of heat to the underlying tissue of the portion of a body subjected to such radiation. It is also an object of the invention to provide a lamp which can be used with safety and over a considerable period of time. To this end the lamp is arranged so that the relatively long wave length infra-red rays which are non-penetrating and which may unduly heat or damage the surface of the skin are substantially cut out, so to speak, and are not radiated and thus not applied to the subject. Moreover, it is an object of the invention to substantially cut out or eliminate the shorter non-penetrating rays, such as those of visible light having wave lengths lower than that of red. Accordingly, it will be seen that the rays from the lamp are substantially concentrated in that range of wave length or zone which include the visible red and relatively short wave length infra-red, these being penetrating rays which will reach the underlying tissue.

These and other objects will become more apparent as the detailed description progresses, and a lamp for carrying out the invention is disclosed in the accompanying drawing.

Fig. 1 is a general view of the lamp.

Fig. 2 is an enlarged cross sectional view showing various structural features.

Fig. 3 is an elevation of the front of the lamp.

Fig. 4 shows a curve illustrating the percentage of the transmission of light according to wave length.

Fig. 5 is an enlarged cross sectional view of one of the filters.

The structural features of the lamp may be comparatively simple and may include a shell 1 with a base 2 having a socket for the reception of an electric lamp 3, the filament of which is suitable for radiating heat rays, while an electrical conductor is illustrated at 4. Within the shell is a reflector 5, the surface of which is preferably gold plated for purposes which will presently appear. The shell may be provided or formed with a bead or shoulder 6 and a second bead or shoulder 7. A filter 8 is designed to be placed against the shoulder 6 so that it is spaced from the lamp 3, and a filter 9 is placed against the shoulder 7.

The shell may be provided with abutment pieces 10 in its lower portion for engaging and holding the filters spaced, while in the upper portion is a clip 11 held in place by a thumb screw 12. In making the assembly the filter 8 is tipped at an angle and its lower edge placed between the shoulder 6 and the pieces 10, and then its upper edge is swung against the upper part of the shoulder 6. The clip 11 may now be located loosely. The screw 12 lies in a slot 13 so that the clip 11 may be pushed toward the open end of the shell. The lower edge of the filter 9 may be located in a recess formation 14 of the pieces 10, and its upper edge in an inverted recess 15 of the clip, and then the filter may be pushed to a position paralleling the filter 8 and the screw then tightened. The filters may have their edges in channel protecting borders 20.

The shell is provided with a number of openings 17 on one side of the filter 8 and a number of openings 18 on the other side for ventilation purposes for reasons which will presently appear. The filter 8 is preferably of clear glass. The filter 9 has a peculiar formation and is what is known as flashed ruby glass.

The rays which have the most penetrating characteristics are those which lie in the wave band of from about 6500 to about 8000 Angstrom units. This includes the visible red rays. Rays having wave lengths less than about 6500 Angstrom units have less penetrating power, and the penetrating power appears to decrease more or less progressively with the decrease in the wave length. Likewise rays having wave lengths which are longer than the above mentioned band have a decreasing penetrating characteristic. However, some of the shorter infra-red rays, that is for example, infra-red rays running up to a wave length of about 14,000 Angstrom units have penetrating characteristics and the decrease in penetration is not so rapid with these rays as it is with the shorter rays. Accordingly, rays in the band of about 6500 to 14,000 Angstrom units are considered penetrating rays. Information, which is believed to be authoritative, is to the effect that about 20% of the rays of about 7500 Angstrom units penetrates through the skin and into underlying tissue. The light radiated by the lamp of this invention is concentrated in this band of penetrating wave lengths.

The reflector employed is preferably gold plated because the gold reflecting surface has a selective reflecting ability and is most efficient in reflecting light within the band wave desired. The reflected light, as well also as some light which is radiated directly from the lamp, is first passed through the clear glass filter. This filter is substantially opaque to the non-penetrating infra-red rays; that is, the rays of long wave length. These waves are stopped by thin layers of water and as the living cells are largely of water, this radiation cannot penetrate deeply. As a result, such rays effect heating at the surface and not only may create an uncomfortable condition, but may at times burn or blister the surface. However, should the filter 8 become heated, it will radiate the non-penetrating ray of long wave length. Accordingly, the shell is provided with the apertures 17 and 18 for the dissipation of the energy which would otherwise cause a radiation of such undesirable wave lengths.

Even with this arrangement for dissipating the heat, the filter 8 may nevertheless become heated and emit some long rays. Accordingly, the filter 9 is employed and it is also cooled because one surface is exposed and the other subjected to air currents passing through the openings 18, and accordingly, it operates cooler than the filter 8. As a result, infra-red rays, which may be radiated by the filter 8, are in a large measure stopped by the filter 9. The filter 9 does not reach such a temperature as to emit or radiate any substantial infra-red rays.

Now as to the peculiar character of the filter 9: This filter is of such a character as to perform at least two functions. The first function is as above noted, namely, that of offering opaqueness to infra-red rays emanating from the filter 8. Its second function is to filter out or offer opaqueness to rays of the lower wave lengths, as for example, those having a wave length less than about 6500 Angstrom units. These are the visible rays in the bands including orange, yellow, green, blue and violet. It will be seen, therefore, that wave lengths in the visible red band are radiated while those both visible and invisible in the shorter wave lengths are minimized and at the same time the infra-red or longer wave lengths are minimized.

The filter 9, as above mentioned, is of the so-called flashed ruby glass. This is a glass, the coloring of which is obtained by the use of copper or gold added to the glass. However, a piece of glass of such thickness that it can be satisfactorily handled as a structural element and which is so colored, has a coloration so intense that it will hardly pass any rays of light therethrough, and obviously, a filter thus constructed would have a very low efficiency, if, indeed, it had any value at all. This is particularly true where copper is used. The use of gold may be so handled that lighter tints may be obtained wherein the intensity of the color is not so great as that of copper, but even with this noble metal a higher efficiency is obtained by the use of the so-called flash glass.

The ruby flash glass is one wherein the main body of glass is clear and it has only a very thin film of the colored glass on one surface. The large cross sectional view of Fig. 5 gives a diagrammatic illustration of this where the body of the glass is shown at 9*a* and the ruby film at 9*b*. This is obtained by a fusion or flash process wherein in the finished article the glass film 9b is united with and constitutes an integral part of the whole, but the coloring lies only in this thin film. Attempts have been made to measure the thickness of this film, but at the present time the exact thickness is not known to the applicant, except to say that the film appears to be thinner than an ordinary sheet of paper. Of course, a flashed glass may be used where both sides have the flash ruby glass, but this is not only unessential but is believed to be detrimental because it would merely undesirably increase the intensity of the color and thereby cut out some of the desired rays.

Tests have shown that a lamp of this construction is highly efficient. The two filters function largely in filtering out the infra-red rays, while the ruby flash glass filters the shorter wave lengths, including those in the visible range and those of the invisible ultra-violet. The curve (Fig. 4) gives the percent of transmission of light at various wave lengths, given in terms of Angstrom units. The curve starts at approximately 6000 Angstrom units, and it will be seen that the percentage runs high, say from about 60 to 73% to about 25,000 Angstrom units. At this point the curve drops rapidly. Now, as above pointed out, the most penetrating rays are those having a wave length of about 7500 Angstrom units, but, of course, there is an efficient penetrating radiation throughout a range which may be stated as being from about 6500 Angstrom units to about 14,000. Wave lengths longer than 14,000 have some penetrating value, but in the higher bands, say from 27,500 Angstrom units up to 120,000 Angstrom units, the penetrating value is low, and these are undesirable because of the surface heating. The curve shows definitely an abrupt drop from about 25,000 to 27,500, with the result that the percentage of transmission of light having a wave length of about 35,000 Angstrom units is dropped to less than 5%.

Further tests have shown that, of the total radiation of light from the lamp of this invention, 95% was less than 27,500 Angstrom units. This, it will be seen, includes the highly penetrating band; and although some infra-red rays having wave lengths in excess of 27,000 are transmitted, the proportion or ratio is so small that the lamp can be used hour on end continuously without any disturbing or uncomfortable surface heating and with no deleterious effects from this standpoint.

Accordingly, it will be seen that a lamp is provided which has a high efficiency in the radiation of light in the penetrating wave bands, while the radiation of light of wave lengths on both sides thereof, namely, the long wave length infra-red, and the shorter visible and infra-red wave lengths are practically eliminated.

We claim:

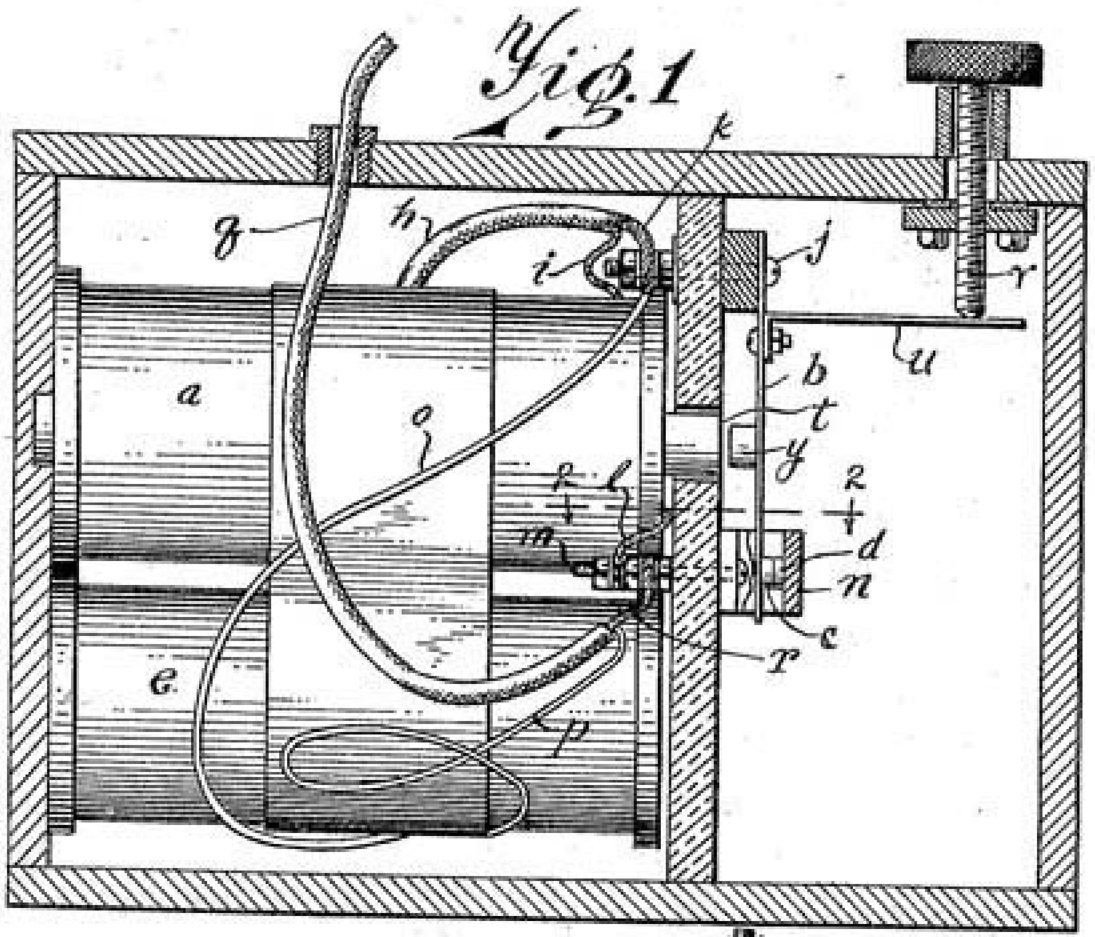
1. A radiant energy lamp for radiating penetrating visible red and short infra-red rays, comprising in combination, a light source, a reflector therefor, a substantially clear glass filter for filtering out non-penetrating relatively long wave length infra-red rays, a second filter spaced from the first filter and comprising a body of substantially clear glass having on a surface thereof a thin film of ruby glass, said second filter serving to filter out long wave length infra-red rays which may have their source at the first filter, and the ruby glass film serving to filter out rays in the visible band having wave lengths shorter than that of red rays.

2. A radiant energy lamp for radiating penetrating visible red and short infra-red rays, comprising in combination, a light source, a reflector

J. H. EASTMAN.
ELECTROTHERAPEUTIC APPARATUS.
APPLICATION FILED SEPT. 22, 1919.

1,345,537. Patented July 6, 1920.

Fig. 1



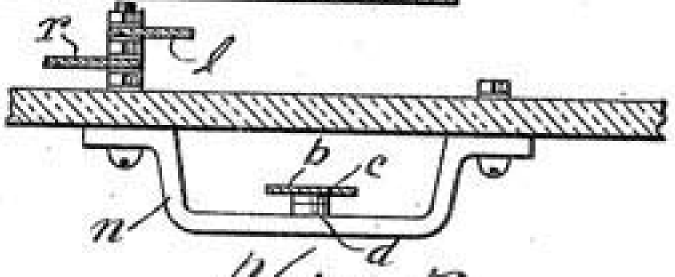


Fig. 2

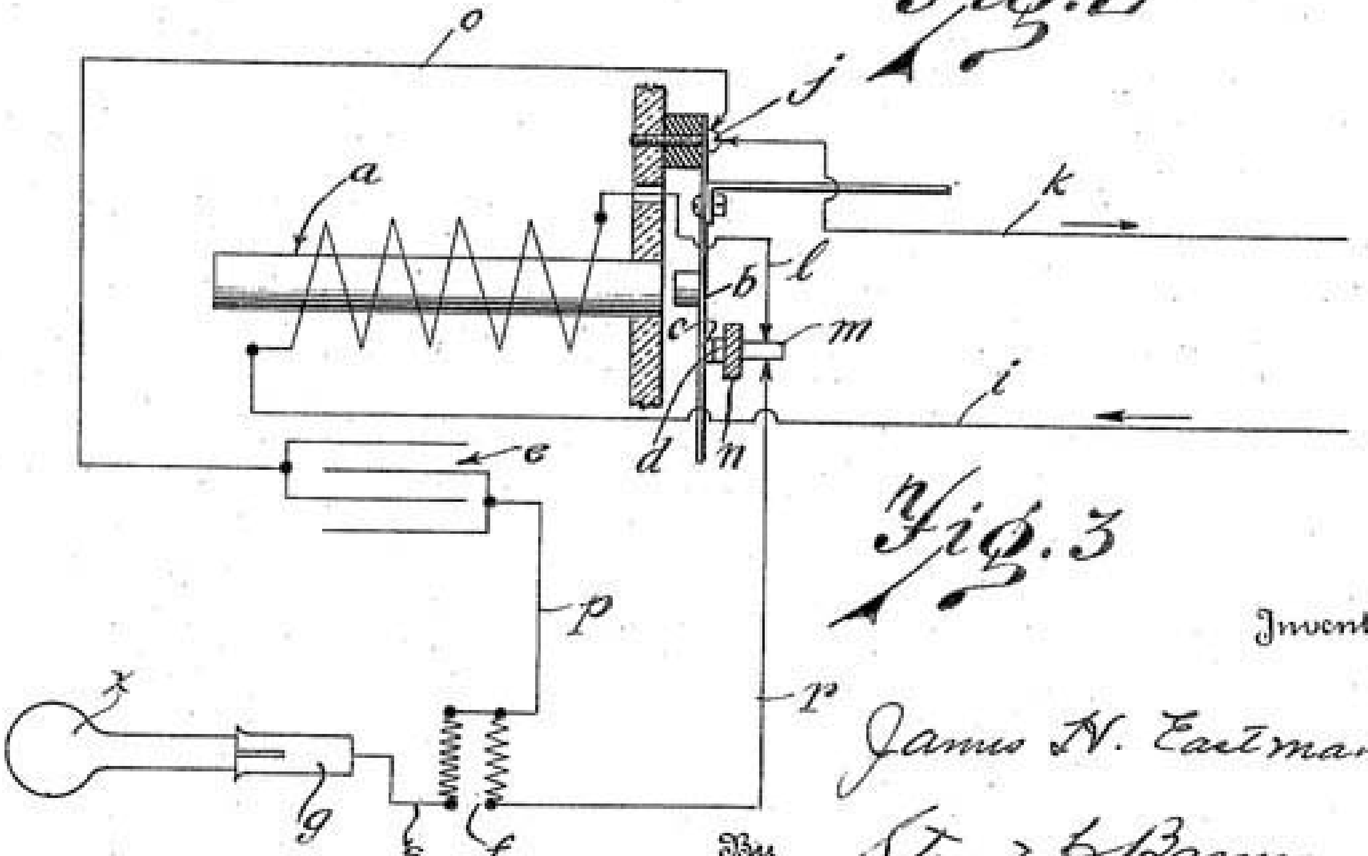


Fig. 3

Inventor

James H. Eastman

By Stuart C. Barnes

Attorney

A.D. 1904. Dec. 31. N° 29,337.

Gaiffe's Provisional Specification.

(1 SHEET)

[This Drawing is a reproduction of the Original on a reduced scale]

Fig. 1.

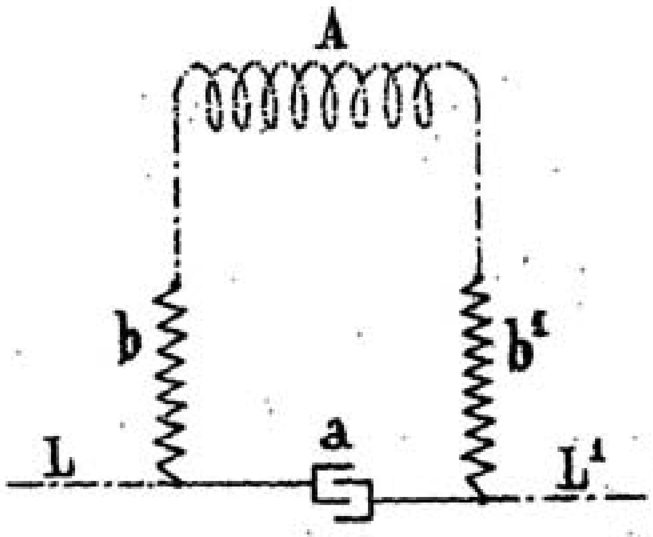


Fig. 2.

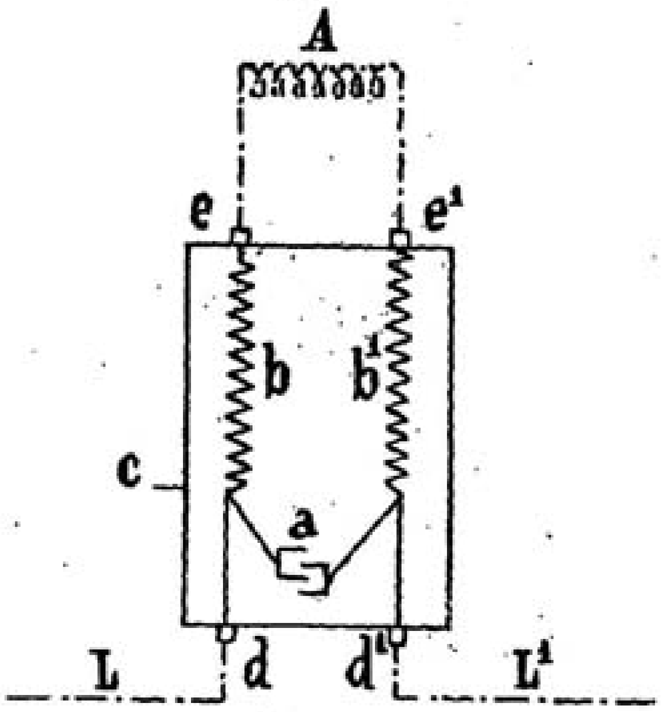


Fig. 3.

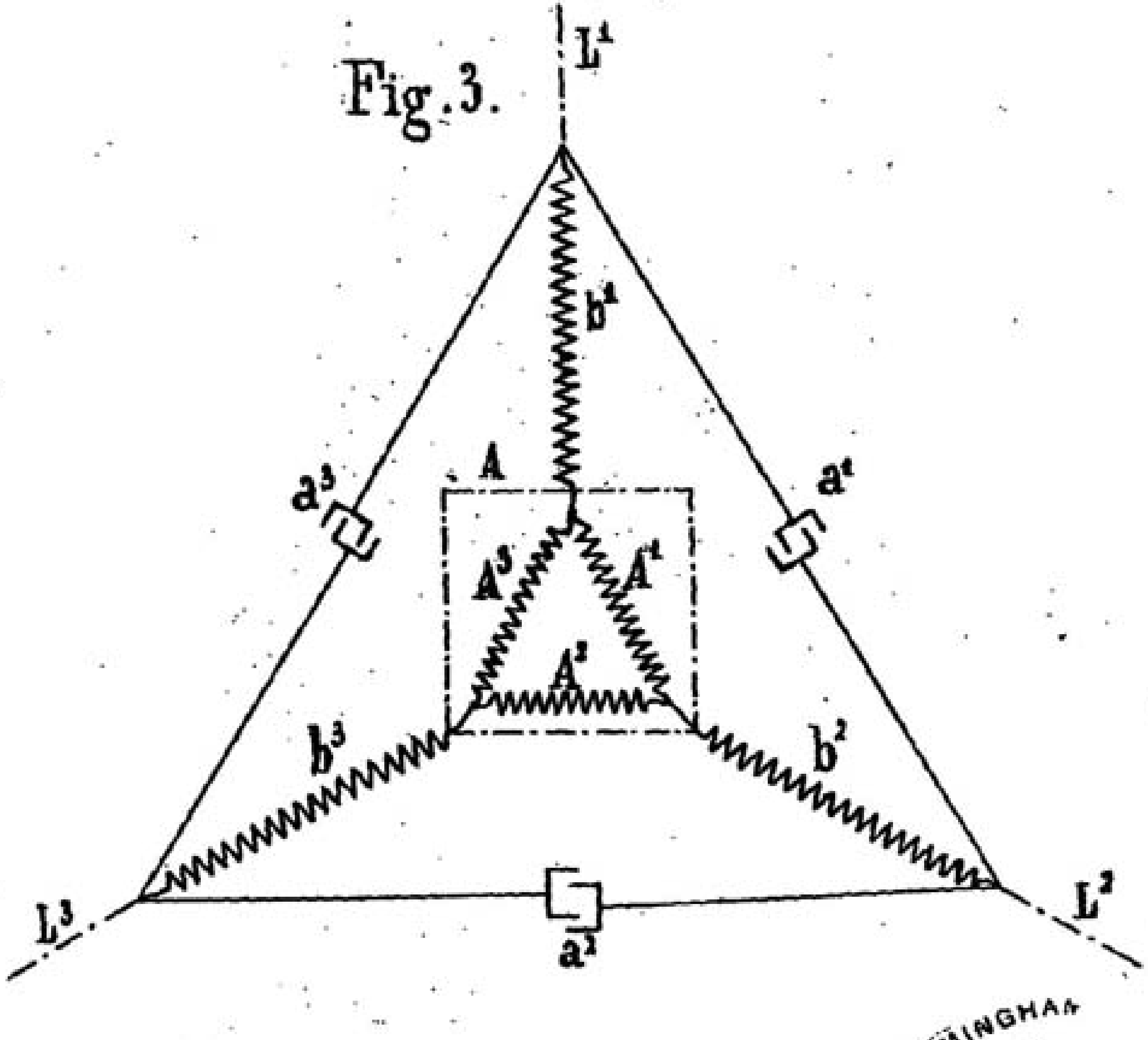


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Figure 8 is a similar view of a modified form of interrupter, and Figure 9 is a plan view of a star-shaped disc employed in this modification. Figure 10 is a similar view of the connections of the latter device; the motor winding being in series with the induction coil circuit. Figure 11 shews another modification wherein the motor winding is placed in shunt with the coil circuit.

As is shewn in Figures 1 and 3 the circuit breaker comprises a receptacle *a* containing mercury *b*, and a block *c* (which may be of conical form) of iron or other non-amalgamable metal, mounted to rotate within the receptacle and keyed upon a vertical shaft *d* operated by an electro-magnetic motor. This block *c* which projects into the mercury has a small inclined channel *e* debouching at one end at the lower surface of the cone at a point o^1 near the periphery thereof, and at its other end at a point e^2 on the periphery of the block *c* (Figures 1 and 3), so that rotary movement communicated to the block *c* will cause the mercury to penetrate the channel *e* rise therein under the action of centrifugal force, and be projected out of aperture e^2.

The aperture e^2 rotates in front of a toothed ring *f* which is connected to one of the poles of the source of electricity and insulated from the body of the apparatus which is in electrical connection with the other pole of said source. The circuit is thus intermittently closed by the projection of the mercury upon the teeth of the ring *f*, the period of the passage of the current depending for a given angular velocity of the block *c* upon the size of the teeth before which the aperture c^2 successively presents itself.

In order to permit of the regulation of this period the toothed ring *f* is carried by racks *g* with which engage two pinions *h* keyed upon a spindle *i* capable of rotating in a bearing *j* attached to the cover *k* of the receptacle *a*; the spindle *i* being provided with a milled head *l* to facilitate its manipulation for the purpose of either lowering or raising the ring *f* so that its teeth may present a greater or a less surface to the aperture e^2.

The motor is constituted simply by an armature *m* mounted to rotate above electro-magnets *n* to which the shaft *d*, carrying the conical block *c*, is fixed.

The position of the aperture e^2 relatively to the poles of the armature *m* is so determined that the current is broken at the moment when the armature is being attracted by the electro-magnets.

The connections are made as shewn in Figure 4. The current successively traverses the motor winding, that is the electro-magnets *n*, the circuit breaker *c*, *f*, and the coil *o* placed in series, and, if desired, a rheostat *p*.

Condensers are placed in shunt with the circuit breaker.

If a source of current is connected up with such a motor the latter remains stationary since the circuit is closed by the interrupter *c f*, but it suffices to manually operate the armature *m* to communicate rotary motion to the block *c* which has for effect to throw the mercury out of the orifice c^2 against the toothed ring *f*; the circuit being thus intermittently closed the motor is set in operation and the successive attractions exercised by the electro-magnets *n* on the poles of the armature *m* effect the continuance of the rotation of the latter.

By operating the rheostat *p* the speed and operative intensity of the motor may be increased as desired. For the purpose of regulating the speed of the motor a rheostat *q* may equally well be placed in shunt with the motor, the current passing partly through the electro-magnet coils *n* and partly through the shunt.

This means of regulation is especially useful when, during the period of contact, the current has not time to assume its normal value, for, in this case, the inductionless shunt appreciably diminishes the total self-induction of the whole circuit and increases the rapidity of the establishment of the current.

The windings *n* of the motor and the coil o^1 instead of being in series as in the foregoing arrangement may be placed in parallel as illustrated in Figure 5 wherein *c* is the movable body of the interrupter, *f* is the fixed toothed ring, n the motor winding, q the regulating resistance of the motor, o the induction coil, and p the regulating resistance thereof.

In this arrangement it is advisable, in order to render the means for regulating the motor and the coil independent, to insulate the extremities n^1 and o^1 of the motor winding and the coil winding respectively. To this end the toothed ring f of the interrupter will be formed as shewn in Figures 6 and 7 with two groups of teeth insulated from one another, the one f^1 corresponding to the motor, and the other f^2 to the induction coil; the former f^1 having for example a rectangular profile so that the period of the passage of current may always remain constant, and the latter f^2 a triangular profile so as to permit of varying the period of the passage of current through the coil. By this arrangement the coil may be regulated without changing the speed of the motor.

Figure 8 shows a modified form of an interrupter having an inclined axis, wherein the armature m rotating in front of the electro-magnets n actuates a shaft d to which is keyed a star-shaped disc (Figure 9) having a number of teeth corresponding to the poles of the motor. The connections are made as shown in Figure 10, wherein the above described combination of parts appears.

As has been said above the motor and the coil windings in the case of a circuit breaker having an inclined axis can equally well be placed in shunt (as seen in Figure 11) so as to permit of the independence of the means of regulating the motor and the coil. The shaft d in this case carries two star-shaped discs c^1 c^2 insulated from one another, whereof the one c^1 is connected to the extremity of the motor winding n and the other c^2 to the extremity of the coil winding o.

Having now particularly described and ascertained the nature of the said invention and in what manner the same is to be performed, I declare that what I claim is.

1. An automatic mercury interrupter consisting of the combination of an induction coil, a rotary electro-magnetic motor operating with intermittent direct current and connected either in series or in shunt with the induction coil circuit, and a mercury interrupter producing the intermittent and simultaneous closure of the motor circuit and of the induction coil circuit, the said combination permitting of the employment of a motor of very simple winding and necessitating the use of a single interrupter only.

2. In an automatic mercury interrupter of the kind claimed in Claim 1, the employment of a conical block secured to a vertical shaft which is rotated by an electro-magnetic motor, the said block dipping into the mercury and being provided with a small inclined channel e debouching at one extremity at the lower surface of block at a point situated near the periphery of the latter, and at the other extremity at the upper part of the block at a point e^2 situated on the periphery of the block; a ring f connected to one pole of the source of electricity and provided with angular teeth concentric with the cone and arranged at a level with the orifice e^2 (the body of the apparatus being placed in communication with the other pole) the arrangement being such that the mercury into which the block dips and which penetrates into the channel e rises in the latter under the action of centrifugal force and is thrown on to the ring f whose position may be regulated vertically to cause the teeth to present to the aperture e^2 a greater or a less surface for the purpose specified.

3. An automatic mercury interrupter of the kind claimed in Claims 1 and 2, wherein the induction coil and the motor winding are placed in shunt, characterised by the fact that the toothed ring of the circuit breaker has two groups of teeth insulated from one another, one group having teeth of rectangular profile and the other group having teeth of angular profile the former corresponding to the motor and the latter to the coil, so that the period of the passage of current on the one hand through the motor may be constant while on the other hand the current through the coil may be capable of being regulated.

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4. The modified form of automatic mercury interrupter claimed in Claim 1, characterised by the fact that its shaft is inclined and carries at its extremity a star-shaped disc dipping into the mercury and having a number of teeth corresponding to the number of poles of the motor.

5. The modified form of automatic mercury interrupter claimed in Claims 1 and 4, characterised by the fact that its shaft is inclined and carries two star-shaped discs insulated from one another whereof the one is connected to the motor winding, and the other to the induction coil winding.

Dated this 2nd day of February 1906.

A. M. & WM. CLARK,
Chartered Patent Agents,
53, Chancery Lane, London.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1907.

[This Drawing is a reproduction of the Original on a reduced scale]

Fig. 1.

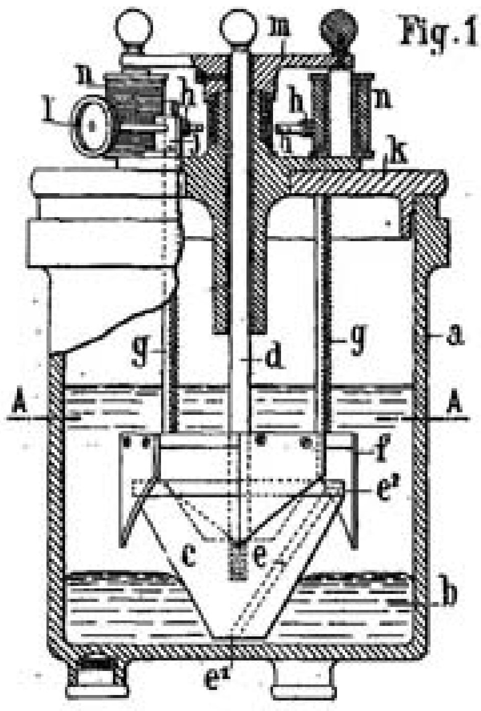

Fig. 2.

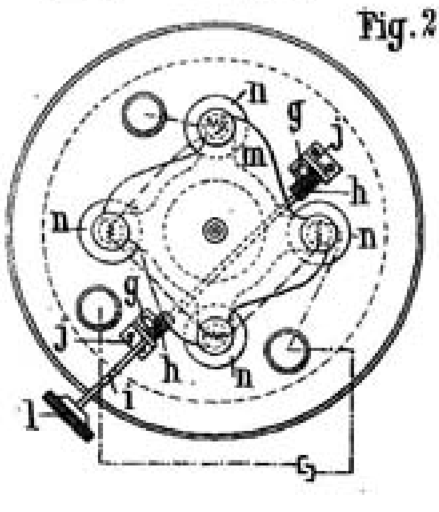

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Fig. 3.

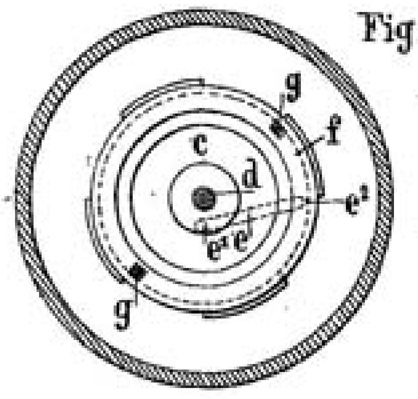


Fig. 4.

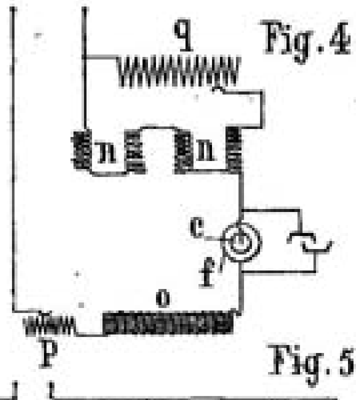


Fig. 5.

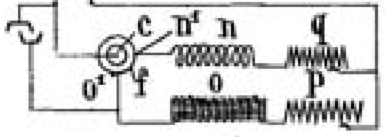


Fig. 6.

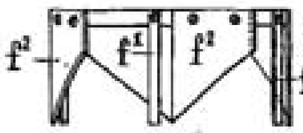
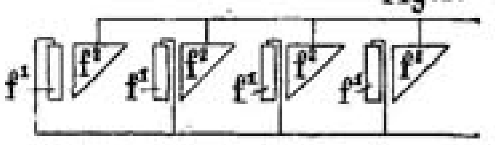


Fig. 7.



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A.D. 1906. Feb. 2. N° 2624.
JAIFFE'S Complete Specification.

SHEET 1

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Fig. 1.

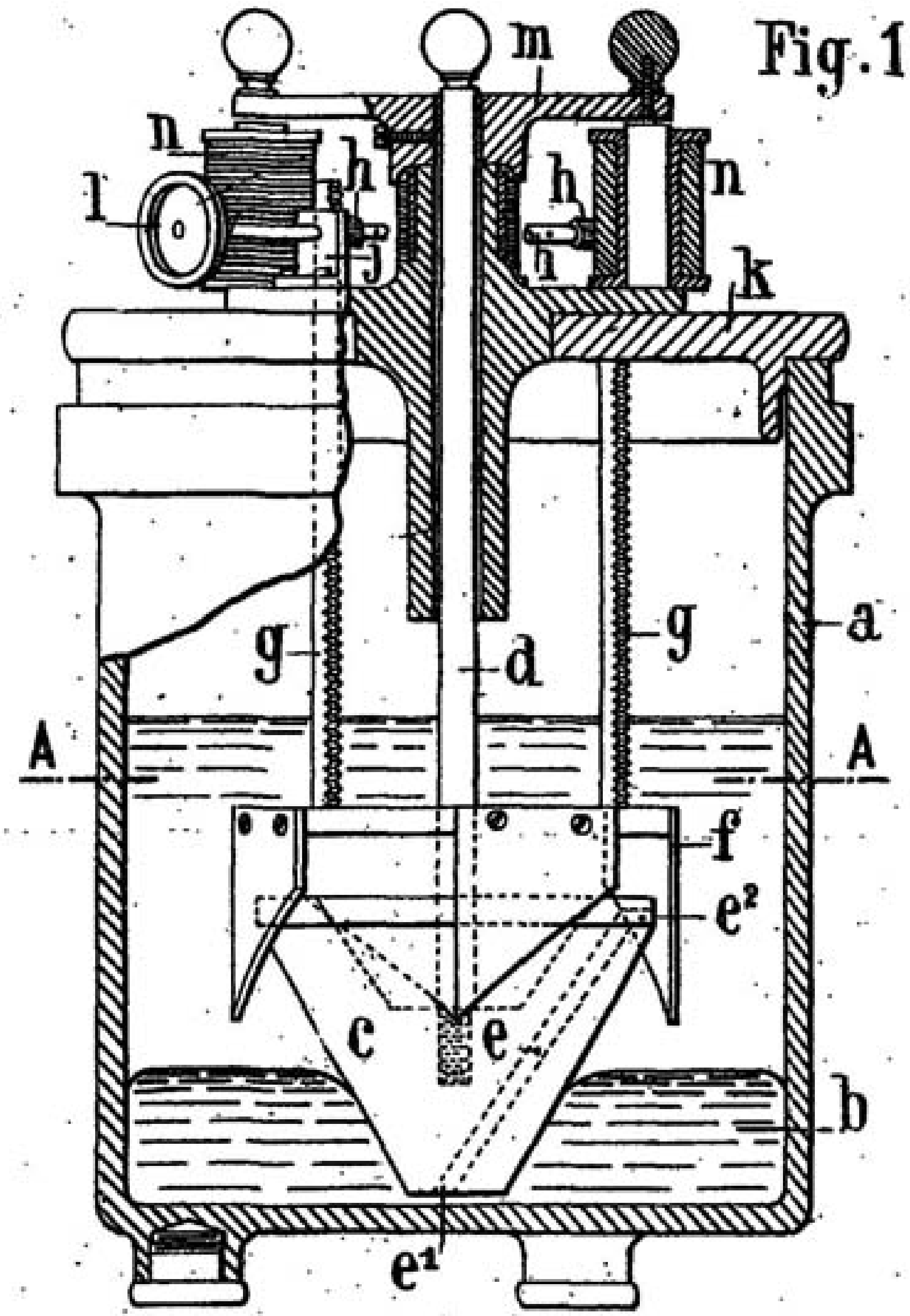

Fig. 2.

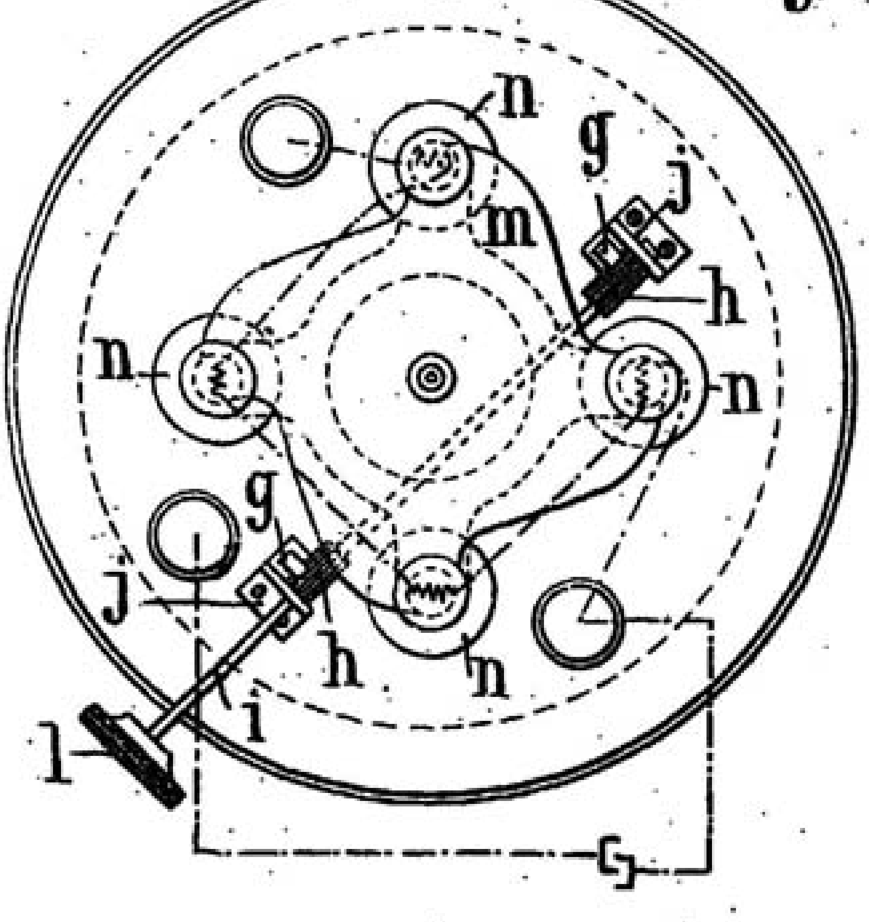

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Fig. 3.

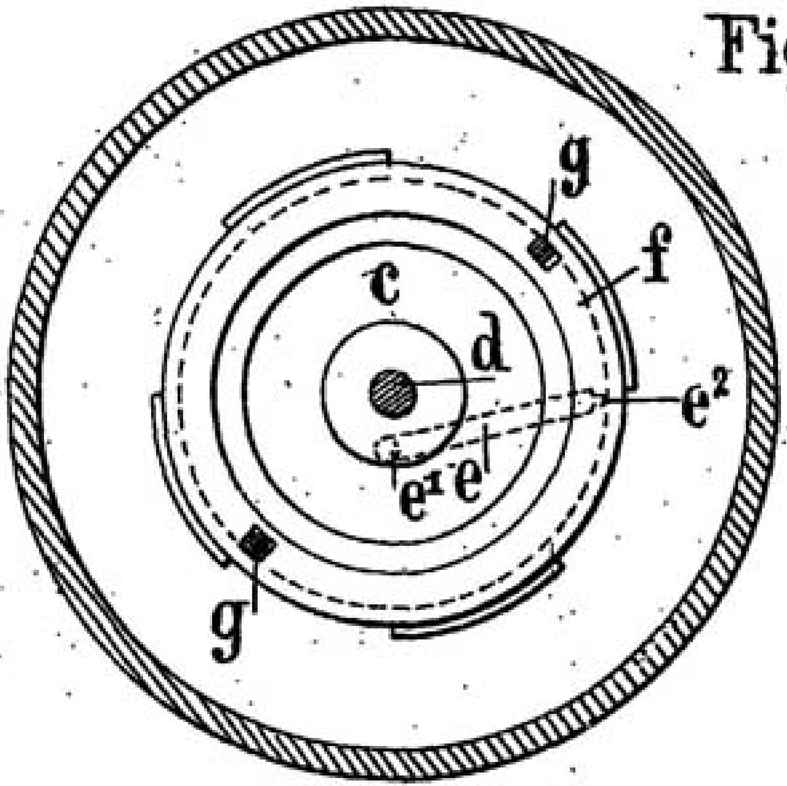

Fig. 4.

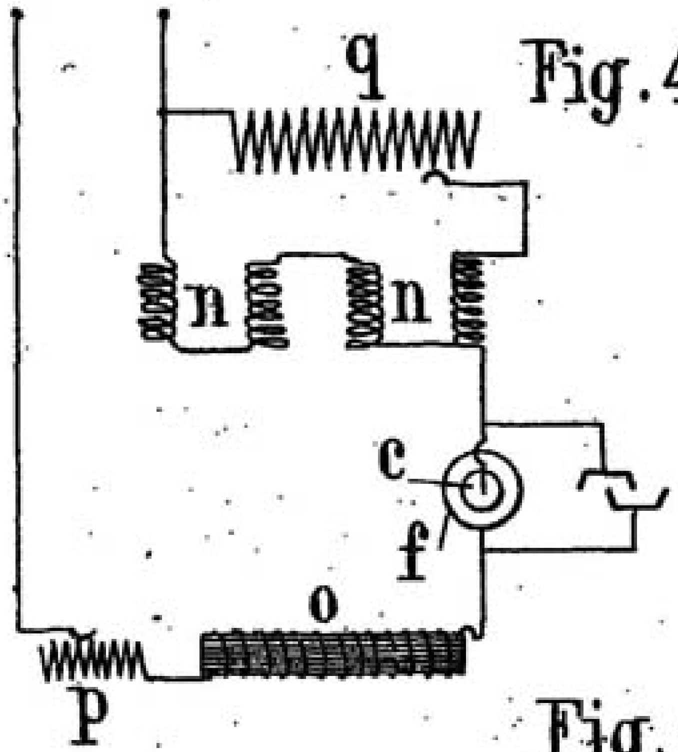

Fig. 5.

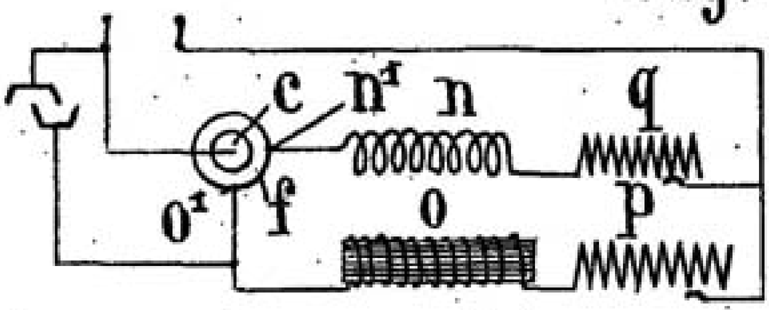

Fig. 6.

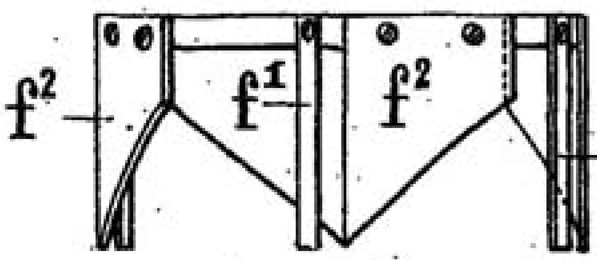

Fig. 7.

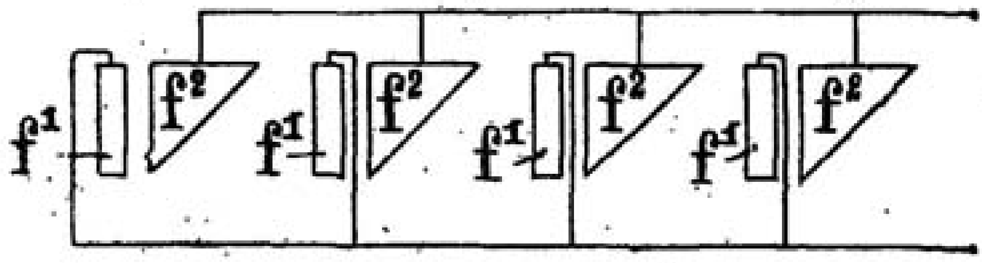

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Fig. 8.

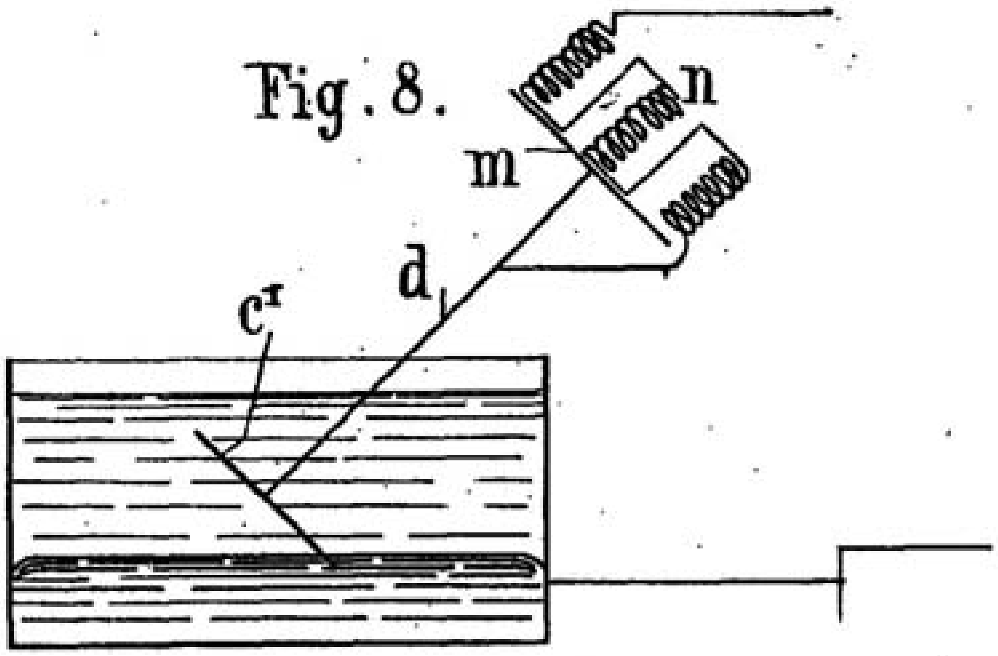


Fig. 9.

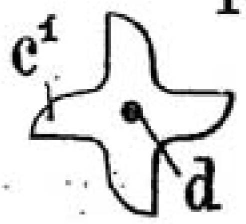


Fig. 10.

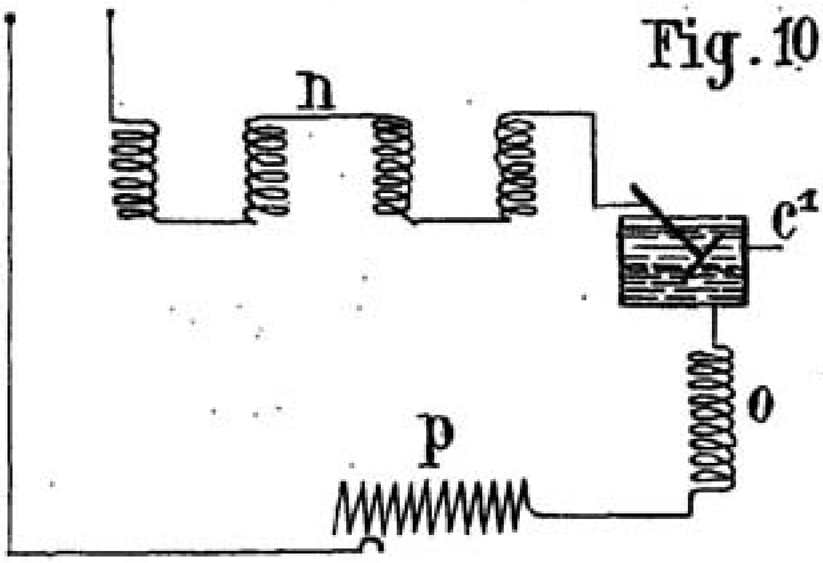
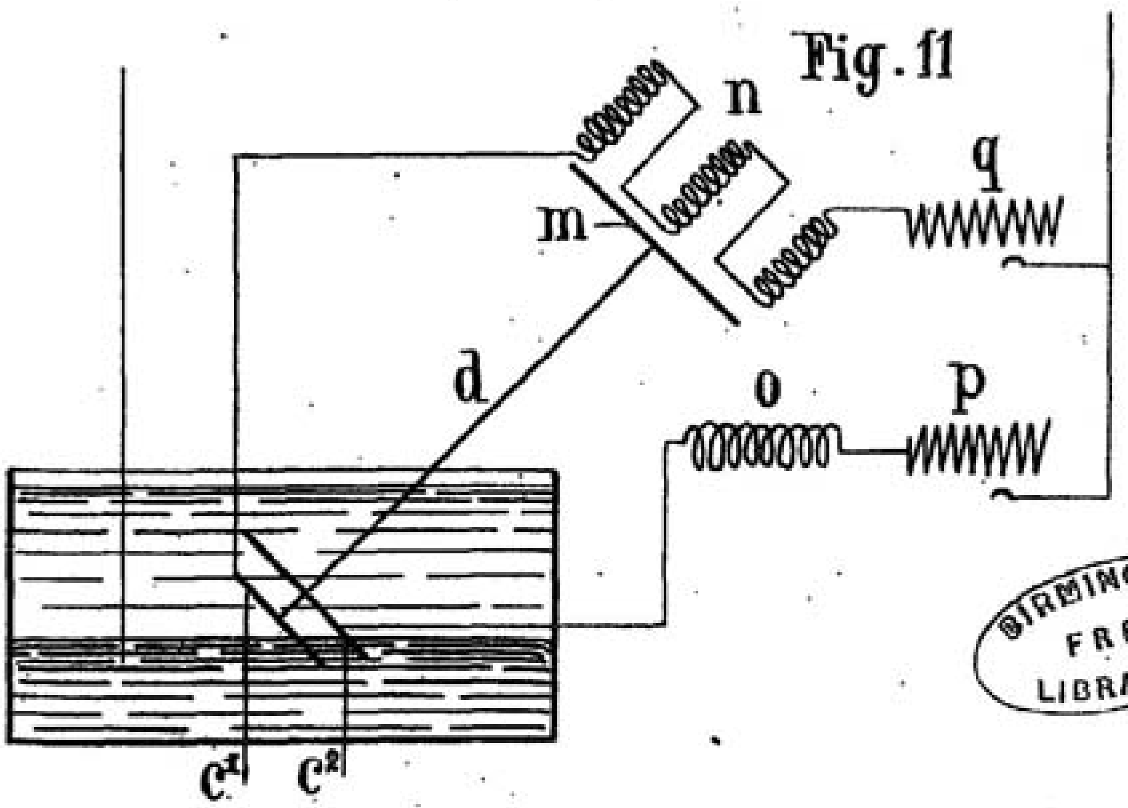


Fig. 11



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Malby & Sons, Photo-Litho.

N° 11,545 A.D. 1904

Date of Application, 19th May, 1904

Complete Specification Left, 17th Feb., 1905—Accepted, 23rd Mar., 1905

PROVISIONAL SPECIFICATION.

"Improvements in Induction Coils."

I, Georges Eugène Gaiffe, of 9, Rue Méchain, Paris, France, Scientific Instrument Maker; do hereby declare the nature of this invention to be as follows.

The efficiency of a Rhumkorff coil, furnished with an interrupter of any type and with a condenser of fixed capacity, is dependent on the conditions of sparking at the trembler, being increased in proportion as this spark is made weaker and of shorter duration.

Inasmuch as this spark closes the inductor upon itself the disappearance of the magnetic flux is more or less instantaneous according as the spark is of shorter or longer duration and, since the electro-motive force of the current induced in the secondary is proportional to the rate of change of flux, the shortening of the duration of the spark has for effect to increase this electromotive force.

The present invention permits of good results being obtained by fractionating or sub-dividing the spark produced at the break in the primary circuit. Under these conditions the electric energy (which originates in, and is transmitted from the primary circuit of the apparatus when working under any given conditions every time the primary is broken and which is constant) works across a number of spark-gaps and since each spark is shorter in proportion to the number of spark-gaps the disappearance of the magnetic flux takes place instantaneously so that a more efficient working of the coil is obtained.

For example let T be the tension, Q the quantity of electricity originating in the primary circuit of the induction coil after each rupture of the same, and t the duration of the spark produced at the single trembler of an ordinary induction coil.

If the circuit be broken at n several points simultaneously instead of at one point only as heretofore, these points of the circuit being connected either in series or in parallel, then in the former case the quantity of electricity which passes at each spark is always Q while the tension across each spark-gap is T/n, whereas in the second case the tension across each spark-gap is T while the quantity of electricity which is transmitted by each spark is equal to Q/n. Hence, in both cases the spark produced at each point of rupture is weaker and its duration is consequently less than t, from which it results that the time occupied in breaking the primary circuit is shorter and consequently the working of the coil is more efficient.

Experience confirms these results. Thus a coil having a single contact breaker and taking 6 amperes at 16 volts can, if furnished with two contact-breakers, be made to give the same output from its secondary when taking only 4 amperes at 16 volts. This, it will be seen, shows an economy of 33% in primary current. On the other hand by providing a coil normally taking a maximum of say 6 amperes at 16 volts with two interrupters working together instead of a single one, the coil can safely take say 12 amperes at 16 volts if the two interrupters are joined in parallel, or 6 amperes at 32 volts if they are joined in series; evidently, then, the use of a plurality of interrupters in

[*Price* 8*d*.]

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place of a single one permits either of a decrease in the input necessary for normal working or of an increase in the output if the input be correspondingly increased.

My invention will be readily understood from the accompanying drawings which show the different forms diagrammatically. The same letters of reference denote like parts in the several figures.

a is the source of current, *b* the primary spool or winding, *c* are the interrupters of the circuit, *d* is the condenser.

For simplicity the secondary winding is not shown. Figure 1 shows three interrupters *c* connected in series in the primary circuit, with a single condenser *d* shunted across the system of interrupters *i.e.* joined to the extreme interrupters on each side.

Figure 2 shows a variant wherein likewise three interrupters in series are provided but in which each interrupter has its own condenser-shunt.

Figure 3 shows three interrupters *c* joined in parallel, the condenser *d* being here joined as a shunt across the system of interrupters.

Figure 4 shows a trembler of the Neef type, having two interrupters joined in parallel. The trembler *e* actuated by the core *f* contained in the interior of the inductor carries two spring contact-pieces g g^1 serving to make contact with two screw-contacts h h^1 which may be adjusted so that the interruption of the current at the two breaks may be readily caused to take place at the same moment. After the initial adjustment, the arrangement is self-regulating, for if one of the two contacts commences to wear away more quickly than the other, the rupture of the circuit only takes place singly, that is at one interrupter, and under these conditions the wear of the one contact will speedily overtake that of the other.

Figure 5 shows another form of interrupter comprising two contact breakers joined in series. This interrupter consists of a rotating disc *e* of insulating material, carrying two copper sectors g g^1 electrically connected to one another and against which the two brushes h h^1 rub. The current furnished by the source of electricity *a* passes, at the instant when the two sectors g g^1 commence to rub against the brushes h h^1, *via* the brush *h*, sector *g*, sector g^1 and brush h^1, then traverses the primary *b* of the coil and thence flows back to the source *a*.

If the pieces composing the double contact-breaker are mounted symmetrically, rotation of the disc *e* will cause the interruption of the current at the two contacts to always occur simultaneously and thus the desired diminution of the duration of the spark will be effected.

The apparatus may be furnished either with a single condenser *d* as represented, or with a condenser for each contact-breaker as above specified.

The present invention may find application to all kinds of induction coils and the details of the arrangements may be varied to suit the particular requirements.

Dated this 18th day of May 1904.

A. M. & WM. CLARK,
Chartered Patent Agents.
53, Chancery Lane, London.

COMPLETE SPECIFICATION.

"Improvements in Induction Coils."

I, Georges Eugène Gaiffe of 9, Rue Méchain, Paris, France, Scientific Instrument Maker; do hereby declare the nature of this invention and in what manner the same is to be performed to be particularly described and ascertained in and by the following statement.

The efficiency of a Rhumkorff coil, furnished with an interrupter of any type and with a condenser of fixed capacity, is dependent on the conditions of sparking at the trembler, being increased in proportion as this spark is made weaker and of shorter duration.

Inasmuch as this spark closes the inductor upon itself the disappearance of the magnetic flux is more or less instantaneous according as the spark is of shorter or longer duration and, since the electro-motive force of the current induced in the secondary is proportional to the rate of change of flux, the shortening of the duration of the spark has for effect to increase this electromotive force.

The present invention permits of good results being obtained by fractionating or sub-dividing the spark produced at the break in the primary circuit. Under these conditions the electric energy (which originates in, and is transmitted from the primary circuit of the apparatus when working under any given conditions every time the primary is broken and which is constant) works across a number of spark-gaps and since each spark is shorter in proportion to the number of spark-gaps the disappearance of the magnetic flux takes place instantaneously so that a more efficient working of the coil is obtained.

For example let T be the tension, Q the quantity of electricity originating in the primary circuit of the induction coil after each rupture of the same, and *t* the duration of the spark produced at the single trembler of an ordinary induction coil.

If the circuit be broken at *n* several points simultaneously instead of at one point only as heretofore, these points of the circuit being connected either in series or in parallel, then in the former case the quantity of electricity which passes at each spark is always Q while the tension across each spark-gap is T/n, whereas in the second case the tension across each spark-gap is T while the quantity of electricity which is transmitted by each spark is equal to Q/n. Hence, in both cases the spark produced at each point of rupture is weaker and its duration is consequently less than *t*, from which it results that the time occupied in breaking the primary circuit is shorter and consequently the working of the coil is more efficient.

Experience confirms these results. Thus a coil having a single contact breaker and taking 6 amperes at 16 volts can, if furnished with two contact-breakers, be made to give the same output from its secondary when taking only 4 amperes at 16 volts. This, it will be seen, shows an economy of 33% in primary current. On the other hand by providing a coil normally taking a maximum of say 6 amperes at 16 volts with two interrupters working together instead of a single one, the coil can safely take say 12 amperes at 16 volts if the two interrupters are joined in parallel, or 6 amperes at 32 volts if they are joined in series; evidently, then, the use of a plurality of interrupters in place of a single one permits either of a decrease in the input necessary for normal working or of an increase in the output if the input be correspondingly increased.

My invention will be readily understood from the drawings accompanying my Provisional Specification which show the different forms diagrammatically. The same letters of reference denote like parts in the several figures.

a is the source of current, *b* the primary spool or winding, *c* are the interrupters of the circuit, *d* is the condenser.

For simplicity the secondary winding is not shown. Figure 1 shows three interrupters *c* connected in series in the primary circuit, with a single condenser *d* shunted across the system of interrupters *i.e.* joined to the extreme interrupters on each side.

Figure 2 shows a variant wherein likewise three interrupters *c* in series are provided but in which each interrupter *d* has its own condenser-shunt.

Figure 3 shows three interrupters *c* joined in parallel, the condenser *d* being here joined as a shunt across the system of interrupters.

Figure 4 shows a trembler of the Neef type having two interrupters joined in parallel. The trembler *e* actuated by the core *f* contained in the interior of the inductor carries two spring contact-pieces $g\ g^1$ serving to make contact with two screw-contacts $h\ h^1$ which may be adjusted so that the interruption of the current at the two breaks may be readily caused to take place at the same moment. After the initial adjustment the arrangement is self-regulating, for if one of the two contacts commences to wear away more quickly than the other, the rupture of the circuit only takes place singly, that is at one interrupter, and under these conditions the wear of the one contact will speedily overtake that of the other.

Figure 5 shows another form of interrupter comprising two contact breakers joined in series. This interrupter consists of a rotating disc *e* of insulating material, carrying two copper sectors $g\ g^1$ electrically connected to one another and against which the two brushes $h\ h^1$ rub. The current furnished by the source of electricity *a* passes, at the instant when the two sectors $g\ g^1$ commence to rub against the brushes $h\ h^1$, *via* the brush *h*, sector *g*, sector g^1 and brush h^1, then traverses the primary *b* of the coil and thence flows back to the source *a*.

If the pieces composing the double contact-breaker are mounted symmetrically, rotation of the disc *e* will cause the interruption of the current at the two contacts to always occur simultaneously and thus the desired diminution of the duration of the spark will be effected.

The apparatus may be furnished either with a single condenser *d* as represented, or with a condenser for each contact-breaker as above specified.

The present invention may find application in all kinds of induction coils and the details of the arrangements may be varied to suit the particular requirements.

Having now particularly described and ascertained the nature of the said invention and in what manner the same is to be performed, I declare that what I claim is.

An induction coil whose primary circuit is provided with two or more contact-breakers for the purpose of interrupting the primary current at several points simultaneously, substantially as and for the purpose specified.

Dated this 17th day of February 1905.

A. M. & WM. CLARK,
Chartered Patent Agents.
53, Chancery Lane, London.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1905.

A.D. 1904. MAY 19. N.º 11,545.
GAIFFE'S PROVISIONAL SPECIFICATION.

(1 SHEET)

[This Drawing is a reproduction of the Original on a reduced scale]

Fig.1.

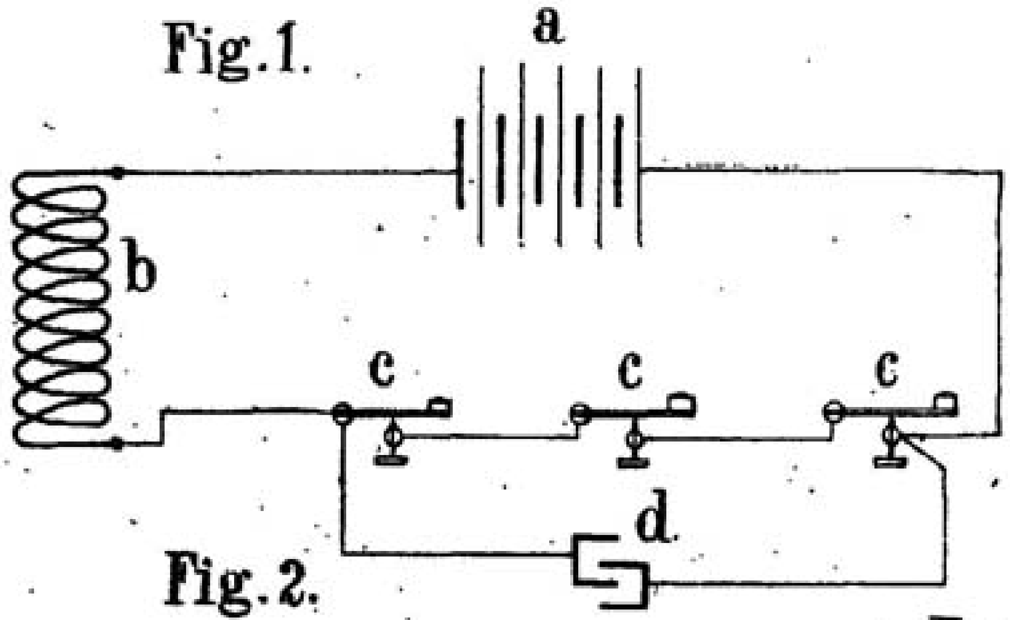


Fig.2.

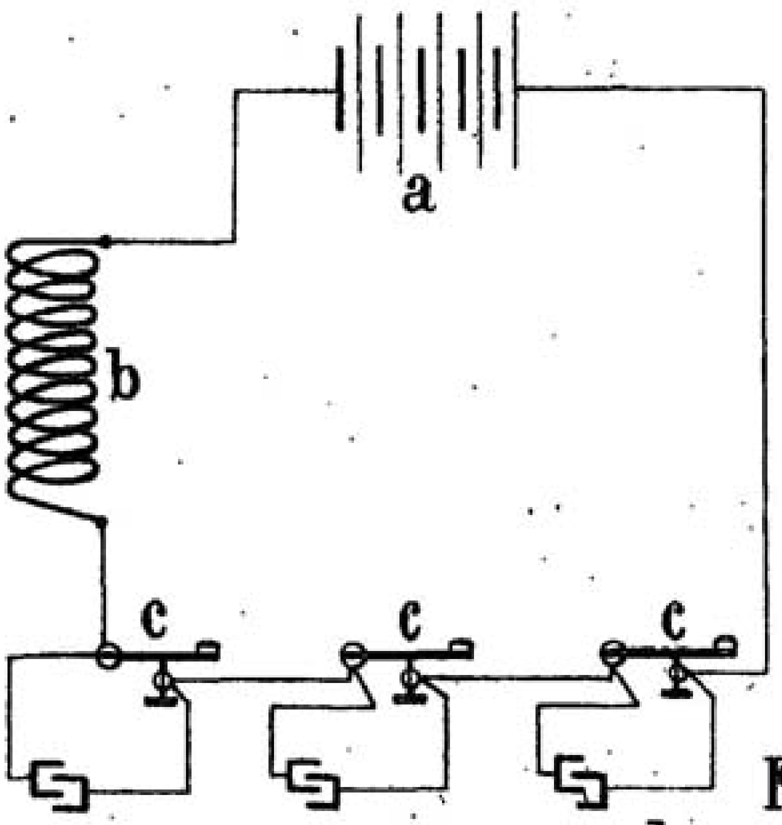


Fig. 4.

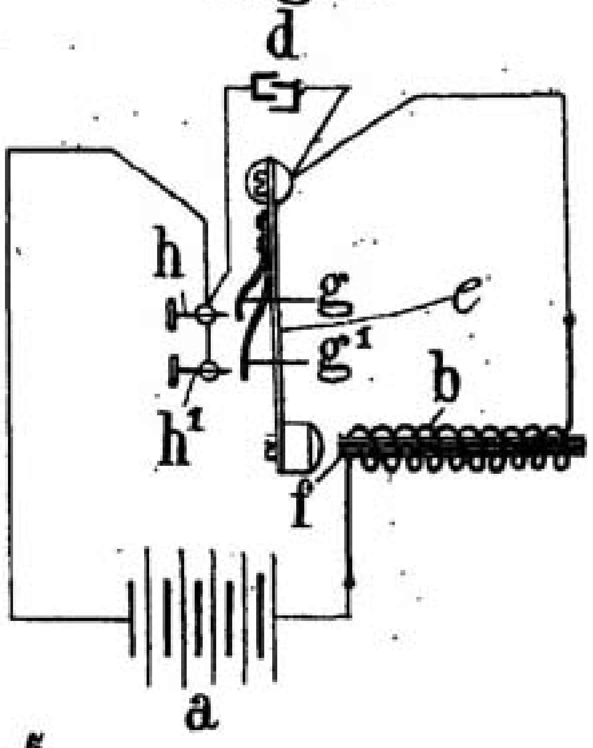


Fig. 5.

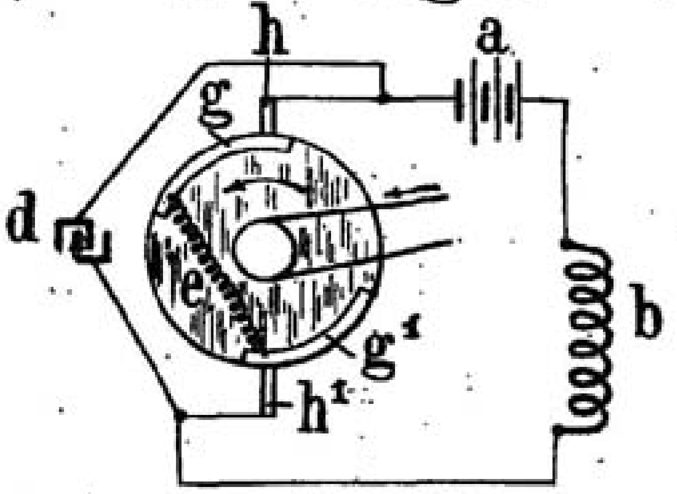
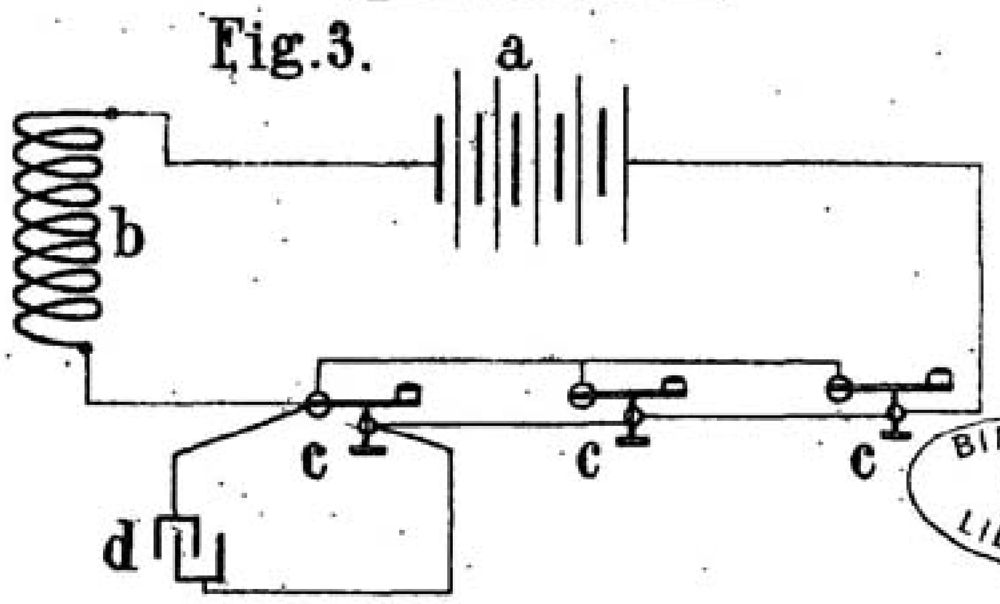


Fig.3.



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Malby & Sons. Photo-Litho.

N° 14,583 A.D. 1902

Date of Application, 30th June, 1902
Complete Specification Left, 11th Mar., 1903—Accepted, 14th May, 1903

PROVISIONAL SPECIFICATION.

"Improvements in Electrolytic Interrupters".

We, Georges Eugene Gaiffe (Electrical Engineer) of 40, Rue Saint André des Arts, Paris, France, and Georges Gallot (Engineer) of 1, Avenue de la Terrasse au Parc, Saint Maur (Seine) France; do hereby declare the nature of this invention to be as follows.

Electrolytic interrupters of the Wenhelt type have hitherto been made with and without means of regulation. In the one case the regulation is effected by causing the platinum electrode of the interrupter to protrude more or less from an insulating sheath in which it is enclosed, so as to vary the active surface of the platinum, while in the other case the platinum electrode is of a certain fixed length determined by the voltage of the electric source and the self induction of the circuit in which the interrupter is employed.

In either case the apparatus is subject to the objection that the platinum soon becomes used by the passage of the current (especially alternating currents) so that the original regulation is no longer maintained.

Our invention consists of an interrupter which is automatically self-regulating, that is to say which after having been regulated or adjusted for a certain result, automatically maintains the same regulation during the whole working of the apparatus.

The invention may be embodied in various forms of apparatus and we will describe two typical arrangements as examples, reference being had to the accompanying drawings.

The essential feature of the first type of apparatus is that its automatic regulation is effected by the employment of a platinum electrode capable of sliding freely in its insulating sheath and resting at its lower end upon a non-conducting support, so that as the platinum rod becomes used it will emerge from its enclosing sheath either by its own weight or under the stress of a spring, or by other mechanical or electro-mechanical means, so that the length of platinum rod immersed in the liquid will thus remain absolutely constant.

In Figure 1 *a* is a tank containing the electrolyte and resting on a platform *b* from which rises a post *c* upon which are mounted the electrodes of the interrupter. *d* is a rod having fixed to its lower end the platinum rod *e* of any desired length, the rod *d* being fitted to slide through a screw-threaded plug *f* which supports the insulating sheath *g* which encloses the platinum rod *e* with the exception of its lower end which protrudes through an orifice in the bottom of the sheath. The screw threaded plug *f* is made of insulating material and screws into a plate *h* also of insulating material from which depend small metal pillars *i* to the lower ends of which are connected a conducting platform *k* which forms the second electrode of the interrupter.

This assemblage of parts may be of any material, even of insulating material, in which case there would be placed in the tank the indifferent electrode of which the action forms no part of the present invention.

At the centre of the platform *k* is placed a block *l* of insulating material, upon which the end of the platinum electrode *e* rests so that as the platinum *e* becomes used the rod *d* will descend by gravity and constantly maintain the

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[*Price* 8*d*.]

platinum in contact with the support *l*, thus maintaining constant the active length of the platinum.

To enable the apparatus to be regulated to suit the conditions of the circuit in which it is used, the insulating sheath *g* is supported by the screw plug *f*, so that by screwing it up or down a greater or less length of platinum rod will be exposed.

The operation of the apparatus is independent of the details of construction which might be varied by making the sheath *g* a fixture and the support *l* adjustable. Moreover the second electrode of the interrupter instead of being constituted by the pillars *i* and platform *k* may be formed by the tank *a*.

Figure 2 represents another arrangement in which an electro-mechanical regulating device is employed, constituted by an armature or core (which may be laminated) interposed in the length of the platinum carrying rod and entering a solenoid traversed by the current which passes through the interrupter. If now by some adjustable mechanical means the drawing in of the core within the solenoid be opposed the opposing forces may be so proportioned as to enable the length of the platinum electrode exposed to the electrolyte and consequently the intensity of the current to be regulated. As every variation of length of the platinum rod exposed corresponds to a variation of the intensity, the solenoid and the force opposed to it will always balance each other so that the length of platinum rod projecting from the insulating sheath will be always maintained constant.

In Figure 2 *a*, *b*, *c*, *d*, *e*, *g* are similar to the correspondingly lettered parts shown in Figure 1, but the rod *d* is made of non-magnetic metal except between the points *x*, *y*, where it is made of iron. This rod passes within a solenoid *m*. The insulating sheath *g* which encloses the platinum may or may not be adjustable. *n* is the second electrode of the interrupter. The electrical connections being as shown, should the platinum become used the resistance of the circuit increases and the solenoid becomes weaker and allows the rod *d* to descend until the normal conditions are re-established. In the arrangement shown the force opposing the solenoid is supposed to be the weight of the rod *d* but any other means may be applied, such as a spring, air piston, brake *etc*.

Dated this 30th day of June 1902.

A. M. & WM. CLARK,
Chartered Patent Agents,
53, Chancery Lane, London.

COMPLETE SPECIFICATION.

"Improvements in Electrolytic Interrupters".

We, Georges Eugene Gaiffe (Electrical Engineer) of 40, Rue Saint André des Arts, Paris, France, and Georges Gallot (Engineer) of 1, Avenue de la Terrasse au Parc Saint Maur (Seine) France; do hereby declare the nature of this invention and in what manner the same is to be performed to be particularly described and ascertained in and by the following statement.

Electrolytic interrupters of the Wenhelt type have hitherto been made with and without means of regulation. In the one case the regulation is effected by causing the platinum electrode of the interrupter to protrude more or less from an insulating sheath in which it is enclosed, so as to vary the extent of active surface of the platinum, while in the other case the platinum electrode is of a certain fixed length determined by the voltage of the electric source and the self-induction of the circuit in which the interrupter is employed.

In either case the apparatus is subject to the defect that the platinum soon becomes used by the passage of the current (especially alternating currents) so that the original regulation is no longer maintained.

Our invention consists of an interrupter which is automatically self-regulating, that is to say which after having been regulated or adjusted for a certain result, automatically maintains the same regulation during the whole period of operation of the apparatus.

The invention may be embodied in various forms of apparatus and we will describe two typical arrangements as examples, reference being had to the drawings filed with our Provisional Specification.

The essential feature of the first type of apparatus is that its automatic regulation is effected by the employment of a platinum electrode capable of sliding freely in an insulating sheath and resting at its lower end upon a non-conducting support, so that as the platinum rod becomes used it will emerge from its enclosing sheath either by its own weight or under the stress of a spring, or by other mechanical or electro-mechanical means, whereby the length of platinum rod exposed to the liquid will thus remain absolutely constant.

In Figure 1 *a* is a tank which contains the electrolyte and rests on a platform *b*, and *c* is a post and arm upon which are mounted the electrodes of the interrupter. *d* is a rod having fixed to its lower end a platinum needle electrode *e* of any desired length, the rod *d* being fitted to slide through a screw-threaded plug *f* from which is suspended the insulating sheath *g* by which the platinum electrode *e* is enclosed with the exception of its lower end which protrudes through an orifice in the bottom of the sheath. The screw threaded plug *f* is made of insulating material and screws into a plate *h* also of insulating material from which depend small metal pillars *i* to the lower end of which are connected a conducting platform *k* which forms the second electrode of the interrupter.

This assemblage of parts might be of any material and even of insulating material, in which case there would be placed in the tank the indifferent electrode whereof the action forms no part of the present invention.

At the centre of the platform *k* is placed a block *l* of insulating material, upon which the end of the platinum electrode *e* rests, so that as the platinum *e* becomes used the rod *d* will descend by gravity and press the platinum upon the support *l*, thus maintaining constant the active length of the platinum.

To enable the apparatus to be regulated to suit the conditions of the circuit in which it is used, the insulating sheath *g* is supported by the screw plug *f*, so that by screwing it up or down a greater or less length of platinum rod will be exposed.

The action of the apparatus is independent of the details of construction which might be varied by making the sheath *g* a fixture and the support *l* adjustable. Moreover the second electrode of the interrupter instead of being constituted by the pillars *i* and platform *k* might be formed by the tank *a*.

Figure 2 represents another arrangement in which an electro-mechanical regulating device is employed, constituted by an armature or core (which may be laminated) mounted on the platinum-carrying rod and entering a solenoid coil in circuit with the interrupter, so that if the pull of the solenoid on the core be opposed by some adjustable mechanical means the opposing forces may be so proportioned that the length of the platinum electrode exposed to the electrolyte and consequently the current strength will be self-regulated, since the latter will vary with every variation of length of the platinum exposed. Consequently the solenoid and the force opposed to it will always balance each other so that the length of platinum rod projecting from the insulating sheath will be maintained constant.

In Figure 2 *a*, *b*, *c*, *d*, *e*, *g* are similar to the correspondingly lettered parts shown in Figure 1, but the rod *d* is made of non-magnetic metal except the part between the points *x*, *y*, which is of iron and which enters the solenoid *m*. The insulating sheath *g* which encloses the platinum may or may not

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be adjustable. In this case *n* is the second electrode of the interrupter. The electrical connections being as shown, should the platinum become used the resistance of the circuit becomes increased and the solenoid becomes weaker and allows the rod *d* to descend until the normal conditions are re-established. In the arrangement shown the force opposing the solenoid is supposed to be the weight of the rod *d* but any other means may be applied such as a spring, air piston, brake *etc.*

Having now particularly described and ascertained the nature of the said invention and in what manner the same is to be performed, we declare that what we claim is.

1. An automatically self-regulating electrolytic interrupter in which a platinum electrode sliding freely through the end of an enclosing sheath is pressed by any suitable means into constant contact with a fixed non-conducting abutment so that the length of the exposed active portion of the platinum is kept constant as described.

2. In a self-regulating electrolytic interrupter of the kind referred to in the preceding claim, making the sheath or the insulating abutment for the platinum adjustable for varying the length of the exposed or active portion of the platinum electrode.

3. An automatically self-regulating electrolytic interrupter wherein the length of the exposed or active portion of a freely sliding platinum electrode is maintained constant by electro-mechanical means dependent on the opposing action of an electro-magnet in series with the interrupter, and of any mechanical means capable of preliminary adjustment according to the strength of current required, all substantially as hereinbefore described.

Dated this 11th day of March 1903.

A. M. & WM. CLARK,
Chartered Patent Agents,
53, Chancery Lane, London.

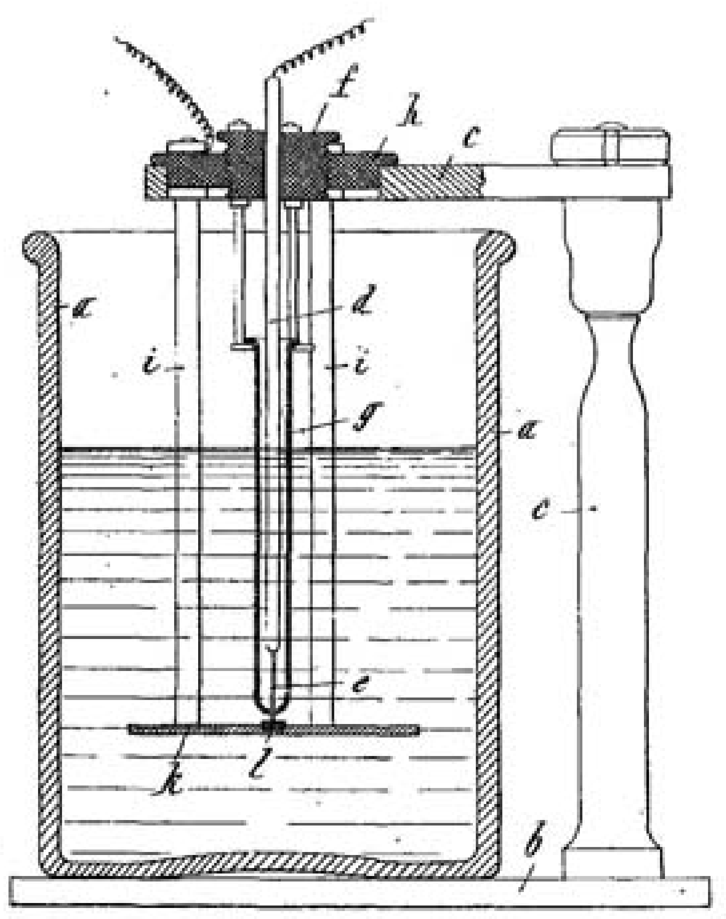
Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1903.

A.D. 1902. June 30. Nº 14,583.
GAIFFE & another's Provisional Specification.

[2 Sheets]

SHEET 1.

Fig. 1.



SHEET 2.

Fig. 2.

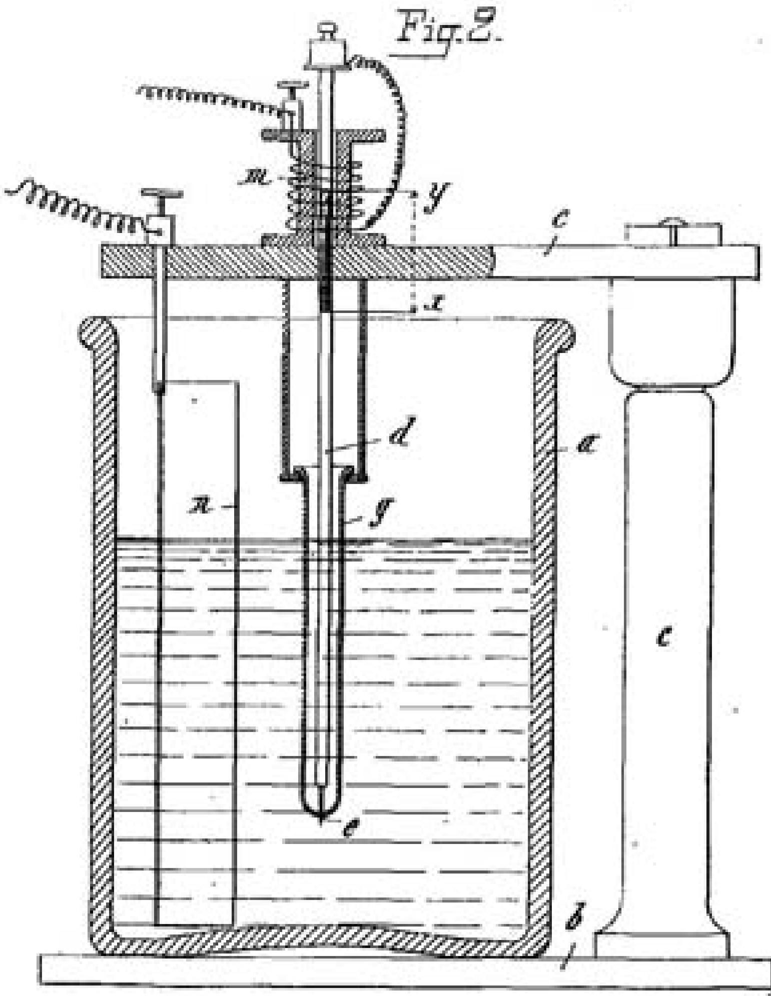


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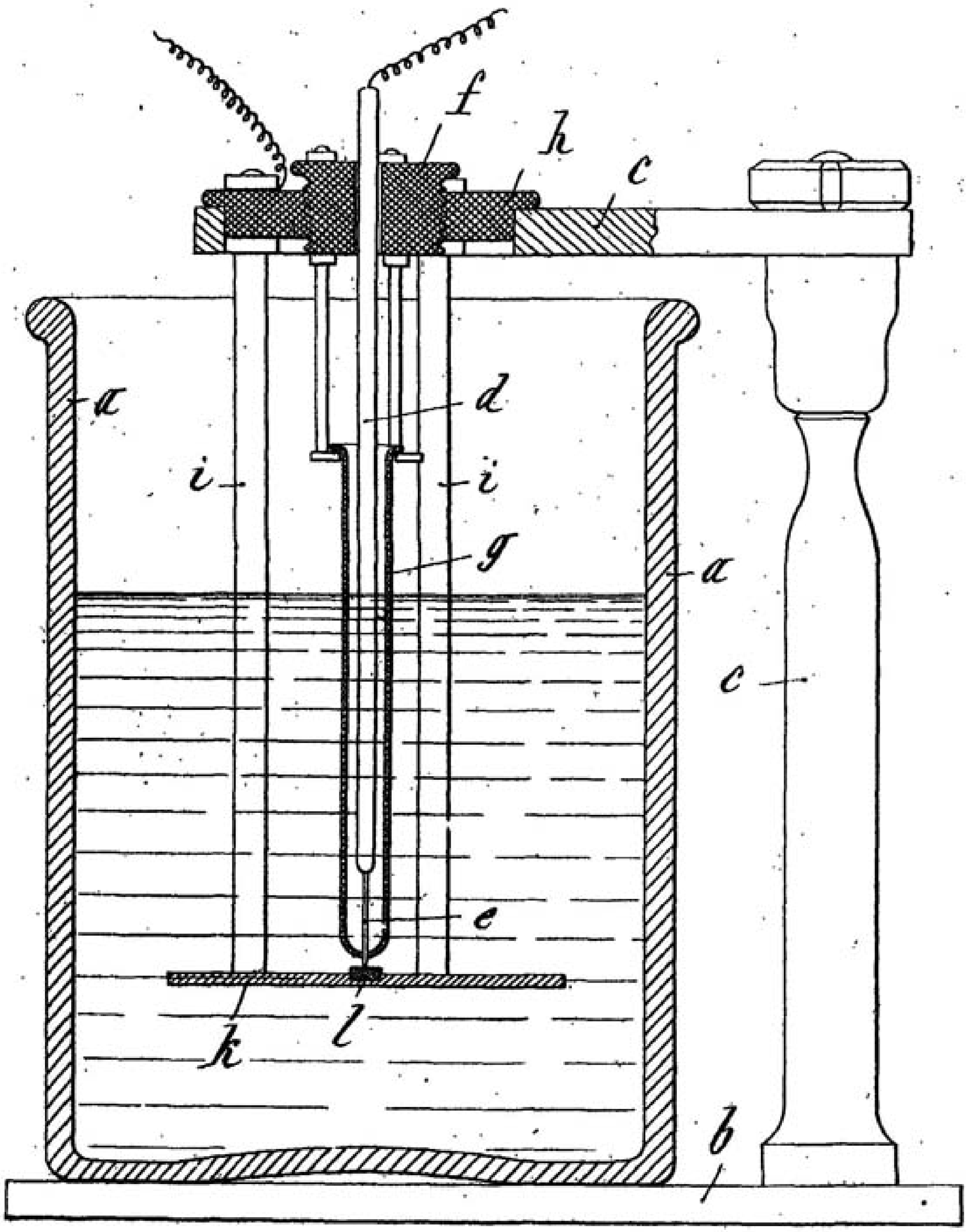
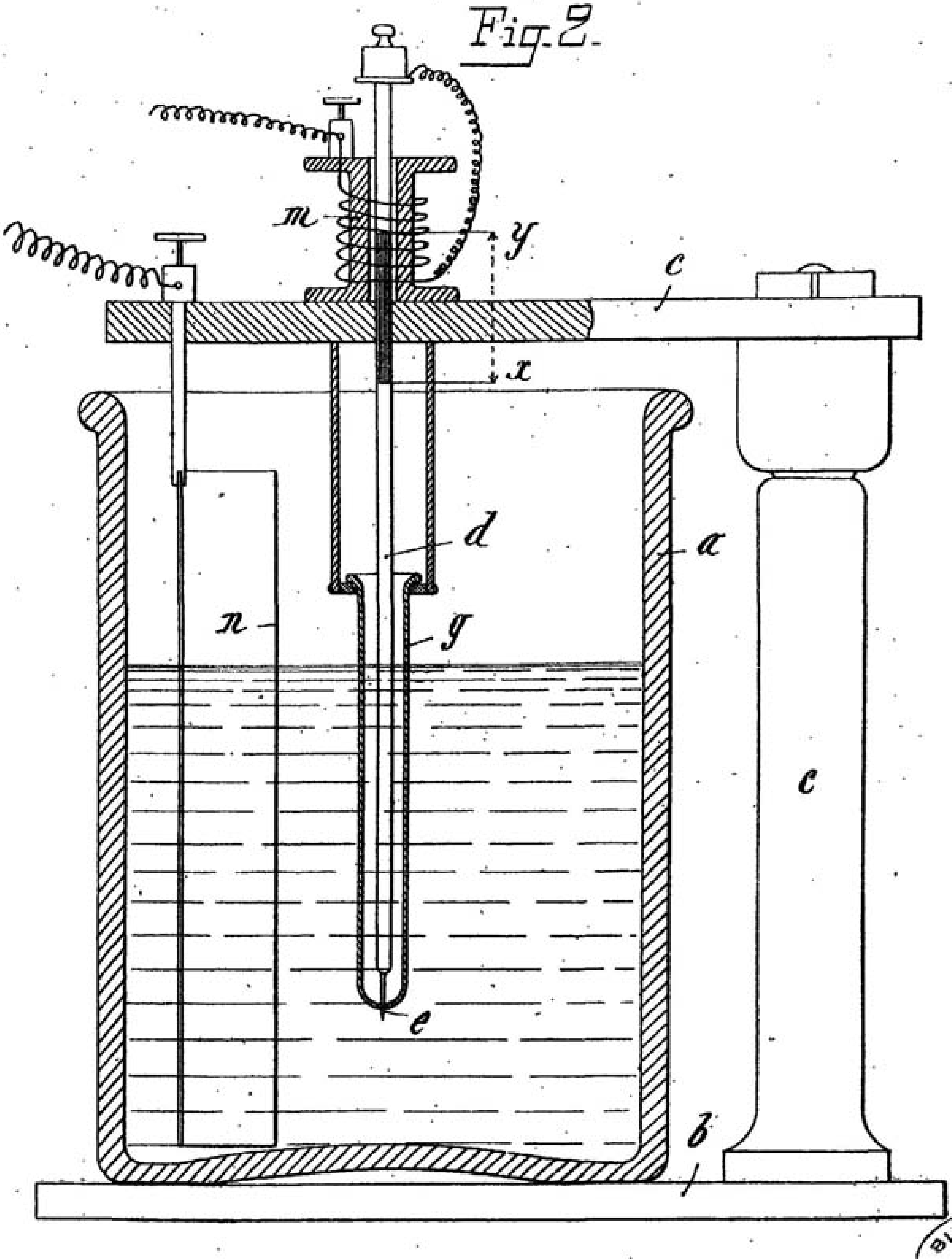
Fig. 1.



(2 SHEETS)
SHEET 2.

Fig. 2.



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N° 16,535 A.D. 1908

(Under International Convention.)

Date claimed for Patent under Patents and Designs Act, 1907, being date of first Foreign Application (in France), } *8th Feb., 1908*

Date of Application (in the United Kingdom), 5th Aug., 1908

Accepted, 21st Jan., 1909

COMPLETE SPECIFICATION.

"Improvements in and relating to Electrical Condensers."

I, Georges Eugene Gaiffe, of 9, rue Méchain, Paris, France, Scientific Instrument Manufacturer, do hereby declare the nature of this invention and in what manner the same is to be performed to be particularly described and ascertained in and by the following statement.

This invention relates to an improvement in electrical condensers intended for use in connection with high tension currents, the object being to prevent the wear of the solid dielectric of the condenser, which wear always takes place at the edge of the metallic electrode of the condenser, where the electrical pressure is greatest.

To attain this object it has been proposed to round the edges of the electrode and to immerse the condenser in a bath of liquid dielectric.

This invention consists in providing the metallic electrode with a distinct edge and separating it from the solid dielectric by a solid body of conducting or non-conducting material forming an extra thickness for the purpose of separating said distinct edge of the metallic electrode from the solid dielectric in order to permit a sufficient thickness of the fluid dielectric interposed between said edge and the solid dielectric.

Referring now to the drawings, Figure 1 is a diagrammatic view of a flat condenser; Figures 2 and 3 are diagrammatic views of modifications. The invention applies equally to other types of condensers (jars or others).

As may be seen in Figure 1 of the drawing, between the solid dielectric a of the condenser (made, for instance, of a glass plate) and the metallic electrode b, is interposed an insulating wedge c made for instance, of glass or paper and of smaller size than the electrode b.

The space d is filled with a fluid dielectric, such for instance as petroleum, air or hydrogen.

A similar insulating wedge c^1 is interposed between the dielectric a and the metallic electrode b^1 on the other side, and the space d^1 is also filled with a fluid dielectric. In this manner the edges t t^1 which are subjected to high electrical pressures do not cause the dielectric a to wear away.

When the electrical pressure appearing at the edge of the electrode reaches a dangerous degree it sets up a movement in the fluid dielectric, which movement produces a cooling effect highly favourable to the preservation of the solid dielectric of the condenser, and at the same time prevents it from wearing away a result probably due to the fact that it absorbs the shocks produced by this electrical pressure on the solid dielectric.

[Price 8d.]

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Another method of carrying out the invention consists in making the wedges *c* and *c*¹ of metal and narrower than the electrodes. These wedges may be in one piece with the electrodes *b* and *b*¹; this arrangement gives the same results as before.

It is also evident that the invention may be carried out by using as the electrodes *b*, *b*¹, electrodes shaped as represented in Figures 2 and 3.

Similarly, in the first method of carrying out the invention, the insulating wedges *c*, *c*¹ might be in one piece with the dielectric *a*, the shape of the solid dielectric becoming the same as that of the wedge *b* in Figures 2 and 3.

Having now particularly described and ascertained the nature of the said invention and in what manner the same is to be performed, I declare that what I claim is.

1. In high tension electrical condensers a metallic electrode provided with a distinct edge and separated from the solid dielectric by a solid body of conducting or non-conducting material forming an extra thickness for the purpose of separating said distinct edge of the metallic electrode from the solid dielectric in order to permit a sufficient thickness of the fluid dielectric being interposed between said edge and the solid dielectric.
2. In high tension electrical condensers in which a space is formed between the solid dielectric and the edge of the metallic electrode, an isolating wedge disposed between the solid dielectric and the metallic electrode, said isolating wedge being of less size than said electrode.
3. In high tension electrical condensers in which a space is formed between the solid dielectric and the metallic electrode, a solid dielectric having projecting parts of less size than the metallic electrode.
4. A high tension electrical condenser constructed and arranged substantially as and for the purpose set forth with reference to Figure 1 or to Figure 2, or to Figure 3 of the accompanying drawings.

Dated this 5th day of August 1908.

A. M. & WM. CLARK,
Chartered Patent Agents,
53, Chancery Lane, London.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1909.

A.D. 1908. Aug. 5. No. 16,535.

GAIFFE'S COMPLETE SPECIFICATION.

(1 SHEET)

[This Drawing is a full-size reproduction of the Original.]

Fig. 1.

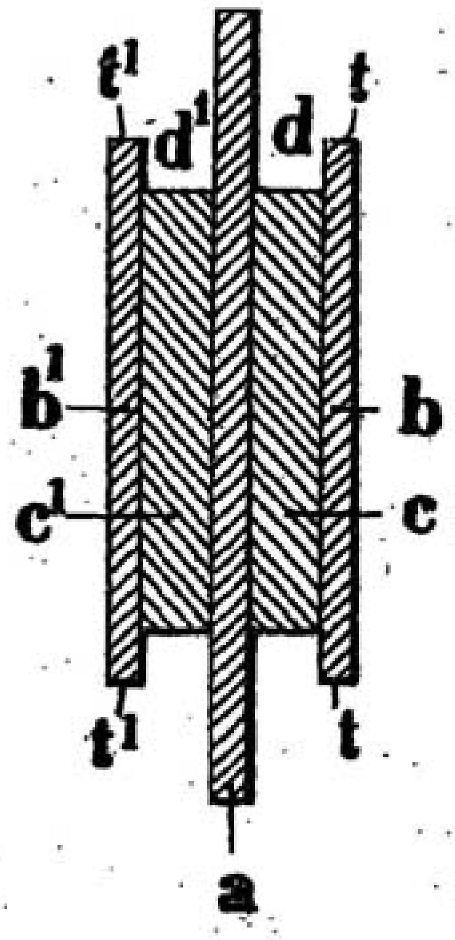


Fig. 2.

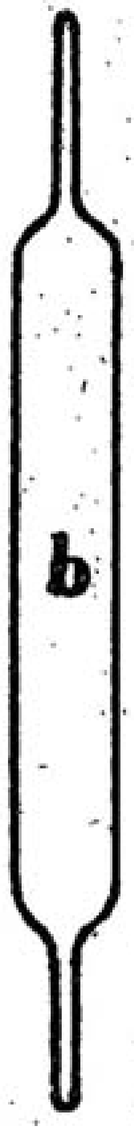
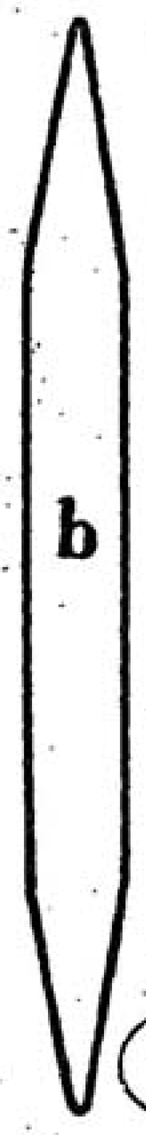


Fig. 3.



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N° 19,477 A.D. 1907

(*Under International Convention.*)

Date claimed for Patent under Patents Act, 1901, being date of first Foreign Application (in France), 3rd Apr., 1907

Date of Application (in the United Kingdom), 30th Aug., 1907

At the expiration of twelve months from the date of the first Foreign Application, the provision of Section 91 (3) (a) of the Patents and Designs Act, 1907, as to inspection of Specification, became operative

Accepted, 23rd Apr., 1908

COMPLETE SPECIFICATION.

"Improvements in Rotary Mercury Interrupters."

I, Georges Eugène Gaiffe of 9. Rue Mechain, Paris, France, Scientific Instrument Manufacturer; do hereby declare the nature of this invention and in what manner the same is to be performed to be particularly described and ascertained in and by the following statement:—

Heretofore rotary interrupters have in some cases been constructed in which the rotor of the interrupter is driven by an attraction motor and the circuit of the motor is periodically closed by the jet of mercury in the same manner as is the circuit of the coil actuated by the said interrupter.

The present invention has for its object to provide an improved form of interrupter device constructed on this principle in which the construction is much simplified, whilst the necessity of providing any adjunct for regulating the speed is entirely dispensed with.

According to the present invention the regulation of the speed is provided for by means of an improved construction based upon the well-known principle of speed regulation by means of movable pole-pieces; that is to say the construction is characterized by the pole-pieces of the motor being made capable of displacement about the axis of the interrupter for the purpose of enabling the distance between these pole-pieces and the movable armature of the motor at the moment when the current traverses the motor circuit to be varied at will.

The invention is illustrated in the accompanying drawings wherein Figure 1 is a vertical section of the apparatus parts being shown in elevation. Figure 2 is a part plan and part horizontal section on line A—A, Figure 1, and Figure 3 is a diagrammatic view of the connections.

As will be seen by the drawing the apparatus comprises a vessel *a* of metal possessing sufficient conductivity and unattackable by mercury, containing a mercury bath *b* covered by alcohol *c* or other insulating liquid. *d* is a conical piece of iron or other non-attackable metal carried by a spindle *e* and dipping into the mercury. *f f* are two passages whose axes lie outside of the vertical plane of the axis of rotation of the system and which terminate in orifices *g* located diametrically opposite one another. In front of these orifices there are arranged two contact pieces *h*, *i* whereof *h* serves to close the circuit of the motor and the other one *i*, that of the induction coil.

When the cone *d* receives rotary movement the mercury rises in the passages *f* and is projected by centrifugal force through the orifices *g*. When the jets of

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mercury encounter the contact-pieces *h*, *i* they establish contact therewith and successively close the circuit of the motor and that of the induction coil as will be seen later on.

The contact pieces *h*, *i* may be fixed or may be movable in the vertical direction by means of racks in which case they are made of triangular profile so that by raising or lowering them the duration of the contact may be varied.

The spindle *e* of the cone is conveniently guided by means of a block *j*; to the upper end of the spindle is keyed a movable armature *k* having a shoulder which rests upon a step-bearing *l*.

The armature rotates between the pole-pieces *m* of an electro-magnet having a winding *n* which constitutes the motor circuit.

The pole-pieces *m* are capable of circular displacement around the axis of rotation of the interrupter by means of a handle *o*. For this purpose they are mounted on or made in one with a base plate *p* turning on the insulating cover *q*. A spring *r* holds this base-plate and the pole-pieces in any position to which they may be brought. From the cover *q* rise insulated terminals *s*, *t* and a terminal *u* connected to the contact-strip *i*. The screws *v*, *x* serve for connecting up the apparatus. The connections are made as shewn in Figure 3.

The two terminals *s*, *t* are connected to the two poles of a source a^1. To these terminals are also connected on the one hand the motor circuit and on the other hand the circuit of the induction-coil b^1 which circuit includes an adjusting rheostat c^1 and a condenser d^1 in a shunt across the terminals *s* and *u* as shewn.

The apparatus is set in action by rotating the cone *d* by means of the milled button d^2. By this means a jet of mercury is discharged against the contact-strip *h*, the motor-circuit is closed through the terminal *s*, the vessel *a* electrically connected to *s*, the mercury bath, the contact *h* and the winding *n* and the terminal *t*. The plan view shews the conductors e^1 and f^1 connecting the winding *n* at the terminal *t* and at the contact-strip *h*. Similarly when the mercury jet strikes the contact-strip *i*, the circuit of the induction coil is closed through the terminal *s*, the mercury, the contact-strip *i*, the terminal *u*, the coil, the rheostat c^1 (Figure 3) and the terminal *t*.

The contact *i* is connected to the terminal *u* through a conductor g^1 as shewn in the plan view.

The two circuits (*viz*, the motor circuit and the coil circuit) are thus closed intermittently by the projection of the mercury against the strips *h* and *i* alternately in such manner that the one is closed only whilst the other is open and *vice versa*. This independent and successive closing of the circuits prevents mutual reaction between them.

At the moment when the electro-motor *n* is excited, the magnetic flux traversing the pole-pieces tends to close itself through the rotating armature and causes the attraction of this armature if it is at this moment approaching the position shewn in the plan view. If the motor circuit be broken at the precise moment when the movable armature occupies the position shewn and when the magnetic circuit is closed as shewn by the arrows 1, the motor will rotate at its maximum speed.

By displacing the pole-pieces no change whatever is made in the electric circuits which are closed at the same instants as in the preceding case but during the time that the motor circuit is closed, the movable armature is no longer in the most favourable position for closing the magnetic circuit; the reluctance of this circuit is increased and the speed is diminished.

Thus it is possible to regulate the speed of the interrupter, and consequently modify the frequency of the interruptions, without any interference with the circuits and more particularly, that of the induction-coil.

Hence by this means a mercurial turbine interrupter is provided wherein the motor-circuit and the coil-circuit have no mutual reaction on one another, notwithstanding that the commutation of the motor (which requires neither brushes nor collectors) is effected by the interrupter itself, whilst, furthermore, the variation of the frequency of the interruptions is obtained without introducing resistances into the motor circuit.

The arrangements above described are only given by way of example as the forms, dimensions and details may be varied in different cases without departing from the spirit of my invention.

Having now particularly described and ascertained the nature of the said invention and in what manner the same is to be performed, I declare that what I claim is:

In a rotary mercurial interrupter in which the motor-circuit and the coil-circuit are successively closed by jets of mercury projected by centrifugal force against contacts, the improved construction characterized by the fact that the electro-motor is furnished with pole-pieces of variable position for the purpose of enabling the rotational speed of the interrupter-rotor to be varied at will solely through the agency of the rotatable pole-pieces and without the introduction of resistance into the motor-circuit, whereby the frequency of the interruptions of the current in an induction-coil or other circuit may be varied as required.

Dated this 30th day of August 1907.

A. M. & WM. CLARK,
Chartered Patent Agents,
53, Chancery Lane, London.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1908.

A.D. 1907. Aug. 30. N° 19,477.
GAIFFE'S COMPLETE SPECIFICATION.

(1 SHEET)

[This Drawing is a reproduction of the Original on a reduced scale.]

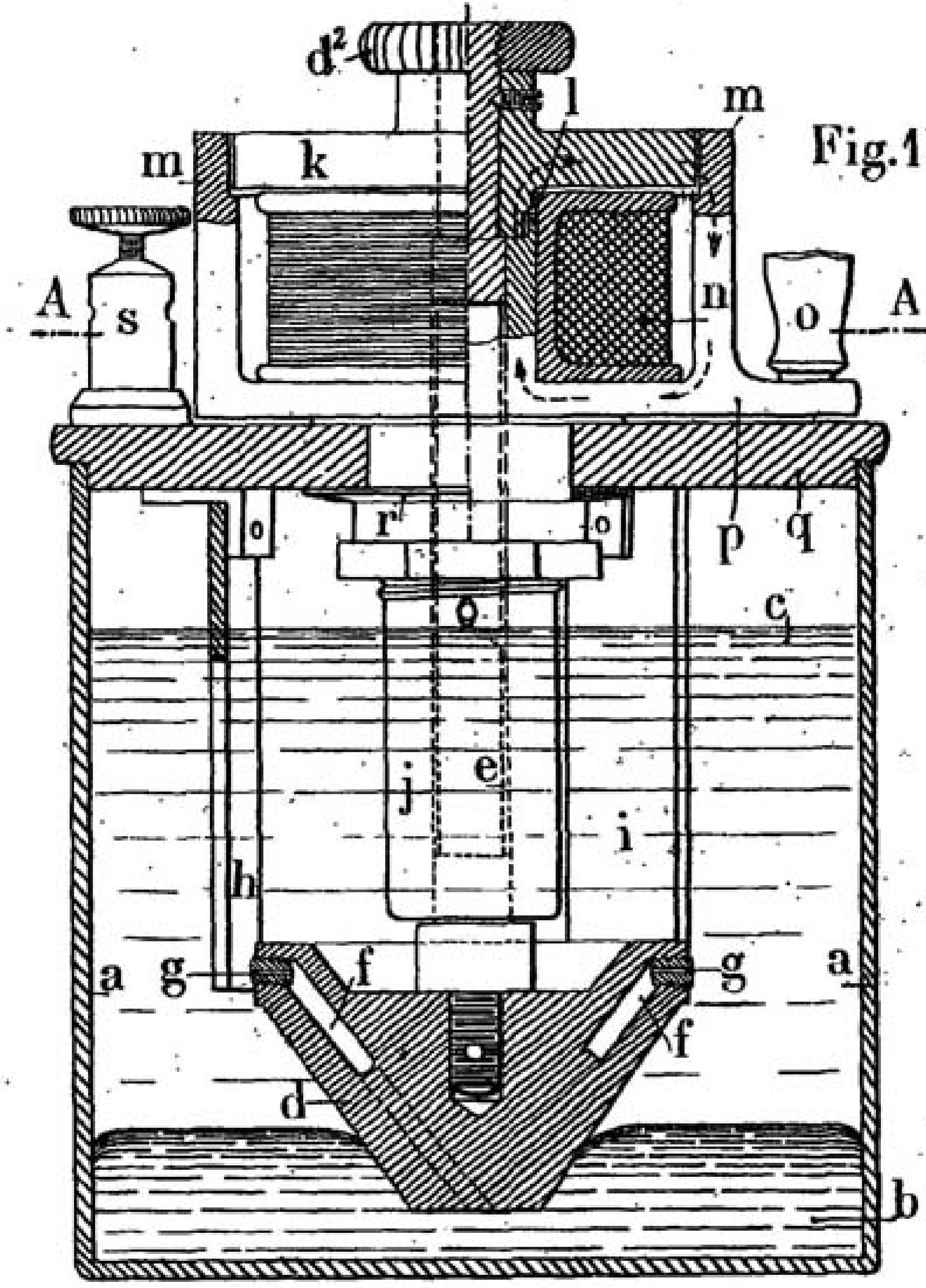

Fig.1.

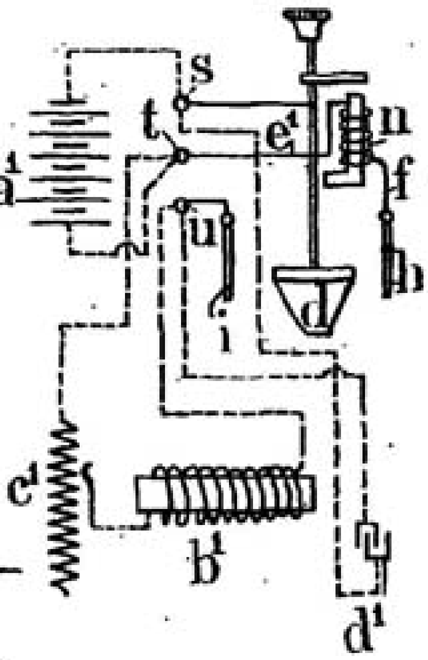

Fig.3.

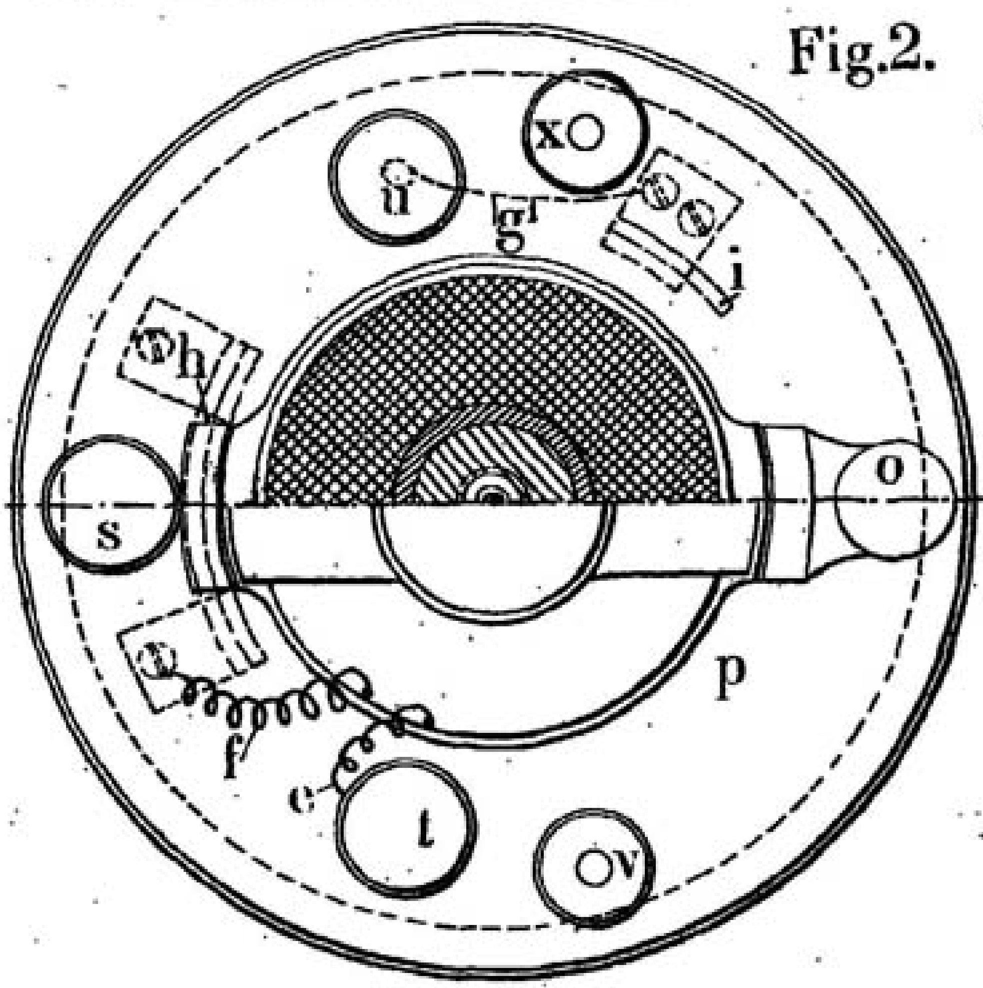

Fig.2.

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N° 28,580 A.D. 1903

Date of Application, 29th Dec., 1903

Complete Specification Left, 28th Sept., 1904—Accepted, 3rd Nov., 1904

PROVISIONAL SPECIFICATION.

"Improvements in or connected with Transformers employed in High Frequency Current Circuits."

I, GEORGES EUGÈNE GAIFFE, of 40, Rue Saint André des Arts, Paris, France, Electrical Engineer; do hereby declare the nature of this invention to be as follows.

High potential transformers, alternating current transformers, Rhumkorff coils *etc.*, which are employed in a circuit producing oscillations of high frequency are themselves traversed by currents of high frequency since the secondary of a transformer is itself a capacity which charges and discharges in the same manner as the main high frequency circuit. Hence electric waves are produced within the secondary of the transformer and these spread lengthwise of the winding at a certain velocity. From this it results that at the same instant, two adjacent points of the winding may be at very different potentials and this difference of potential may amount to the total difference of potential of the transformer. A high potential transformer is thus incapable of working at high frequency unless special precautions are taken.

The present invention has for its object to provide means whereby the above mentioned disadvantage may be remedied.

This invention consists essentially in the employment, with the object of damping the oscillations of high frequency which tend to traverse the said transformer, of resistances either alone or in conjunction with a capacity situated at the extremities of the secondary of the transformer.

The accompanying drawing diagrammatically illustrates the principle of the invention by way of example. Figure 1 shows the resistances applied to the two extremities of the secondary within the transformer itself. Figure 2 shows the resistances applied to the two extremities of the secondary outside the transformer. Figures 3 and 4 show similar arrangements of the resistances and in addition the capacities above referred to.

The same letters of reference indicate the same parts in the several figures.

The safety device shown in Figure 1 is constituted by the application to the extremities of the secondary *a* of the transformer, of windings *b c* (sufficiently well insulated to withstand the high pressures brought into play) having a resistance capable of damping the high frequency oscillations whatever may be their wave length. *d* indicates the high frequency circuit.

The resistance and the insulation of the windings *b*, *c* may be obtained in any suitable manner, as for example by the alternate winding of a wire of high resistance and any suitable insulating material.

The secondary of the transformer thus comprises at each of its extremities a winding whose resistance and insulation are of much greater value than those required in ordinary industrial applications.

In the modification represented in Figure 2 the safety device is constituted by two resistances *b*, *c*, placed in front of the secondary of the transformer upon the respective conductors constituting the prolongations of the extremities of the said secondary. These resistances *b*, *c*, are so constituted as to damp all oscillations and are sufficiently well insulated to prevent sparking between any two points of the resistances.

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To each resistance *b*, *c*, there may be connected a capacity *e*, *f*, as in Figures 3 & 4 additional to the capacity of the wire of the transformer itself. These capacities *e*, *f*, may be of any suitable kind and be so connected that the charging oscillations will have a tendency to traverse the resistance whatever may be the position of this resistance relatively to the transformer. Figure 3 shows the additional capacities *e*, *f*, in the case of resistances placed in the interior of the transformer, while Figure 4 shows the additional capacities *e*, *f*, in the case of resistances placed external to the transformer.

The addition of this capacity permits either with a given resistance of augmenting the damping effect produced by this resistance or (if a stated amount of damping is rendered necessary by the conditions of working), of diminishing the resistance necessary for producing such damping.

The device of this invention is suitable for use with all high potential transformers, alternating current transformers generally, Rhumkorff coils *etc.*, which are employed in circuits in which oscillations of high frequency are liable to be produced, either continuously (as in wireless telegraphy and medical coils) or intermittently as in industrial installations.

Dated this 29th day of December 1903.

A. M. & WM. CLARK,
Chartered Patent Agents,
53, Chancery Lane, London.

COMPLETE SPECIFICATION.

"Improvements in or connected with Transformers employed in High Frequency Current Circuits."

I, Georges Eugène Gaiffe, of 40, Rue Saint André des Arts, Paris, France, Electrical Engineer; do hereby declare the nature of this invention and in what manner the same is to be performed to be particularly described and ascertained in and by the following statement.

High potential transformers, alternating current transformers, Rhumkorff coils *etc.* and in general any source of continuous or alternating current employed in a circuit producing oscillations of high frequency, are themselves traversed by currents of high frequency since the secondary of a transformer is itself a capacity which charges and discharges in accordance with the oscillations taking place in the main high frequency circuit. Hence electric waves are produced within the secondary of the transformer and these spread lengthwise of the winding at a certain velocity. From this it results that at the same instant, two adjacent points of the winding may be at very different potentials and this difference of potential may amount to the total difference of potential of the transformer. A high potential transformer is thus incapable of working at high frequency, unless special precautions are taken.

The present invention has for its object to provide means whereby the above mentioned disadvantage may be remedied.

This invention consists essentially in the employment, with the object of damping the oscillations of high frequency which tend to traverse the said transformer, of resistances either alone or in conjunction with capacities connected to the extremities of the secondary of the transformer.

The accompanying drawing diagrammatically illustrates the principle of the invention by way of example. Figure 1 illustrates an apparatus serving to explain the phenomenon to which are due the dangers peculiar to the working of sources of high potential owing to the production of oscillations of high frequency. Figure 1^a shows the resistances applied to the two extremities of the secondary within the transformer itself. Figure 2 shows the resistances applied to the two extremities of the secondary outside the transformer. Figures 3 and 4 show similar arrangements of the resistances and in addition the capacities above referred to. Figure 5 shows a modification of Figure 4.

The same letters of reference indicate the same parts in the several figures.

Referring to Figure 1, which serves to explain the phenomenon which takes place, *a* is the secondary winding of a high potential transformer; *d* is the high frequency installation. The point *n* of the spark-gap circuit follows the variations of potential produced by the oscillating discharge of the condensers of circuit *d*. Thus if the source has charged the armature *h* of condenser *i* to a potential of + 100,000 volts, that the periodicity of the oscillations in the circuit *d* is 1 million, this shows, supposing the damping of the electric oscillations to be nil, that the point *n* passes from the potential + 100,000 volts to the potential − 100,000 volts with a frequency of 1,000,000 cycles per second, *n* being the extremity of the winding *a* of the transformer.

Whilst these oscillations are being produced the source tends to maintain at the extremities of the transformer a potential which may be considered as constant during a short interval of time, which potential is + 100,000 volts; thus there is at certain moments a potential of − 100,000 volts at one of transformer terminals, whilst the source tends to maintain the potential thereat, at + 100,000 volts. If we consider a point *m* situated in one of the last coils of the winding *a*, it is such that the self-induction of circuit *m*, *n* is sufficient to prevent the rapid variations of difference of potential from + 100,000 to − 100,000 volts at the one terminal of the spark gap from affecting the potential of the point *m* which remains at a potential of + 100,000 volts, less the feeble electro-motive force due to the winding *m n*. Between the points *m* and *n* there are thus instantaneous differences of potential of from + 100,000 to − *100,000* volts, or *200,000* volts, that is to say the total potential difference of the transformer and this constitutes the danger.

The safety device shown in Figure 1^a is constituted by the application to the extremities of the secondary *a* of the transformer, of windings *b c* (sufficiently well insulated to withstand the high pressures brought into play) having a resistance capable of damping the high-frequency oscillations whatever may be their wave length and consequently of keeping the dangerous portion comprised between the extremity *n* (Figure 1) of the transformer and point *m*, independent of the variations of potential of the spark gap. *d* indicates the high-frequency circuit.

The resistance and the insulation of the windings *b*, *c* may be obtained in any suitable manner, as for example by the alternate- or inter-winding of a wire of high resistance with any suitable insulating material.

The secondary of the transformer thus comprises at each of its extremities a winding whose resistance and insulation are of much greater value than those required in ordinary industrial applications.

In the modification represented in Figure 2 the safety device is constituted by two safety-resistances *b*, *c*, placed in front of the secondary of the transformer upon the respective conductors constituting the prolongations of the extremities of the said secondary. These resistances *b*, *c* are so constituted as to damp all oscillations and are sufficiently well insulated to prevent sparking between any two points of the resistances.

To each resistance *b*, *c*, there may be connected a capacity *e*, *f*, as shown in Figures 3 and 4, which is supplemental to the capacity of the transformer winding itself. These capacities *e*, *f*, may be of any suitable kind and are so connected that the charging oscillations will tend to traverse the resistance whatever may be the position of this resistance relatively to the transformer. Figure 3 shows the arrangement of the capacities *e*, *f* in the case when the safety-resistances are placed in the interior of the transformer, whilst Figure 4 shows the arrangement when the resistances are placed externally to the transformer.

The addition of this capacity permits either, with a given resistance, of augmenting the damping effect produced by this resistance or (if a stated amount of damping is rendered necessary by the conditions of working), of diminishing the resistance necessary for producing such damping.

Figure 5 represents a modification of Figure 4. The capacities *e*, *f* (Figures 3 and 4) in this arrangement consist of any suitable condenser *g* sufficiently well insulated. The function of the capacity in the arrangements shown in Figures 4 and 5 may be explained as follows:—

The capacities *e*, *f* (Figures 3 and 4) which may be in the form of a condenser *g* (Figure 5) constitute a reservoir which becomes charged to the same difference of potential as that of the source of this reservoir can only discharge itself slowly through the windings *b* and *c*, so that when point *n* of the spark-gap passes to the potential – 100,000 volts (to revert to the figures before mentioned), the potential of the point n^1 varies but very little inasmuch as the condenser *g* can only discharge but a very small quantity during the millionth of a second during which the oscillation exists, and consequently between the point *m* (see description of Figure 1) and point n^1 only such slight differences of potential will exist as will exclude all possibility of danger to the insulation.

It is to be observed that the resistance may be replaced by self-inductive devices or by the combination of resistance and self-induction, and generally by any means of retarding the discharge of the condensers and damping the return oscillations.

The safety device of this invention is suitable for use with all high-potential transformers, alternating-current transformers, Rhumkorff coils *etc*, and generally with any source of supply of a continuous or alternating current employed in circuits in which oscillations of high frequency are liable to be produced, either continuously (as in wireless telegraphy and medical coils) or intermittently as in industrial installations.

Having now particularly described and ascertained the nature of the said invention and in what manner the same is to be performed, I declare that what I claim is.

1. The employment, for protecting against disruptive sparking the secondary coils of transformers or other sources of high potential acting on circuits producing (or capable of producing) oscillations of high frequency, of means for damping the oscillations consisting of highly-insulated safety-resistances (either inductive or non-inductive) interposed between each of the secondary terminals of the transformer and the high-frequency circuit and adapted to prevent the high-frequency oscillations from being partly or wholly transmitted to the secondary winding of the transformer, substantially as specified and shown in the drawings.

2. The employment in conjunction with each of the resistances interposed between the source of high potential and the high-frequency circuit as in Claim 1, of a capacity substantially as and for the purpose specified.

Dated this 28th day of September 1904.

A. M. & WM. CLARK,
Chartered Patent Agents,
53, Chancery Lane, London.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1904.

A.D. 1903. Dec. 29. No. 28,580.

(1 SHEET)

GAIFFE'S PROVISIONAL SPECIFICATION.

Fig. 1.

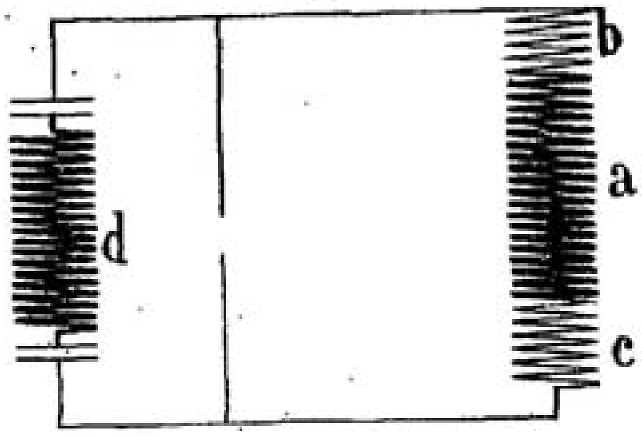


Fig. 2.

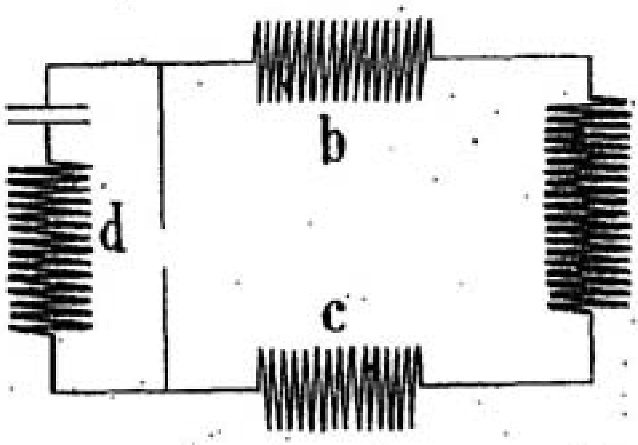


Fig. 3.

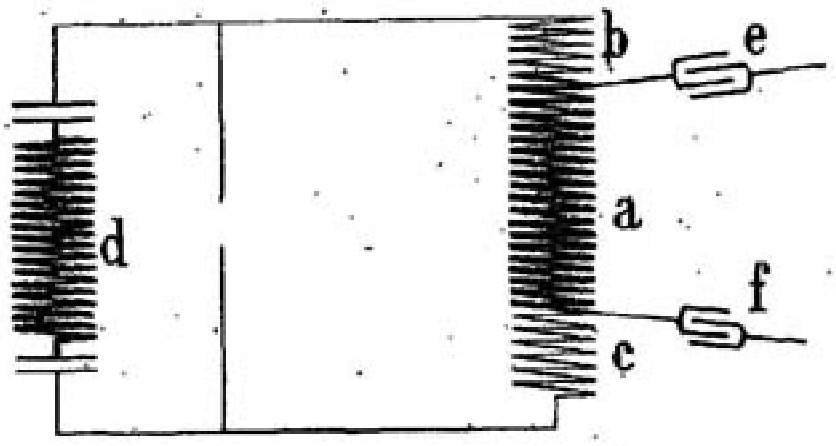
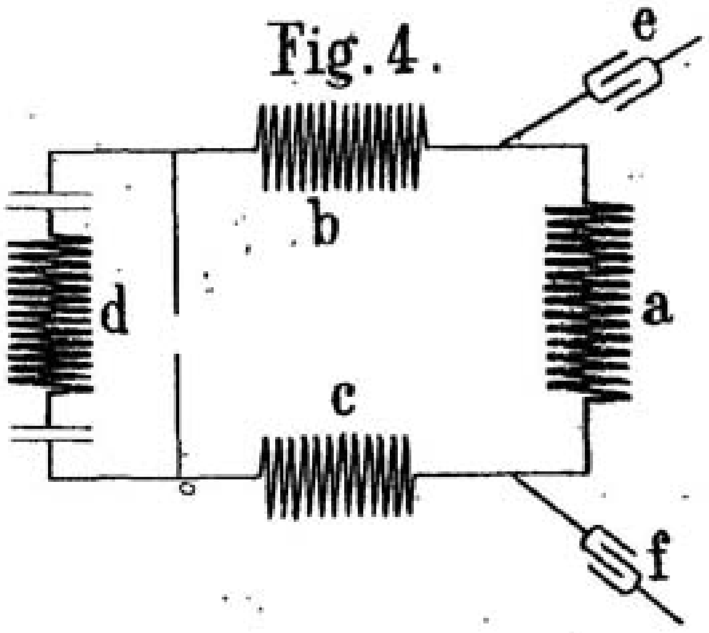


Fig. 4.



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A.D. 1903. Dec. 29. No. 28,580.
GAIFFE'S Complete Specification,

(1 Sheet)

Fig. 1.

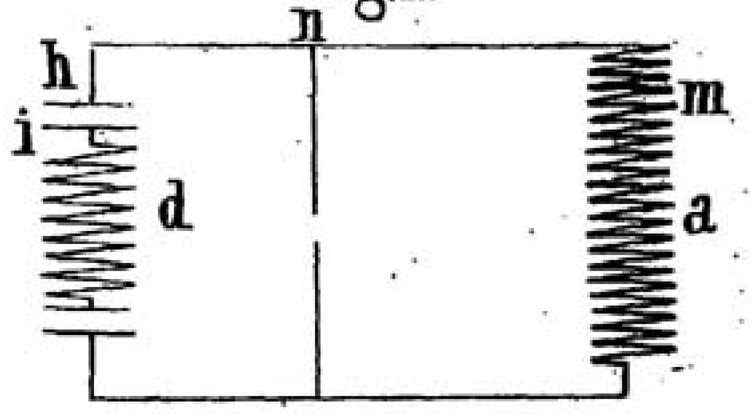


Fig. 1a.

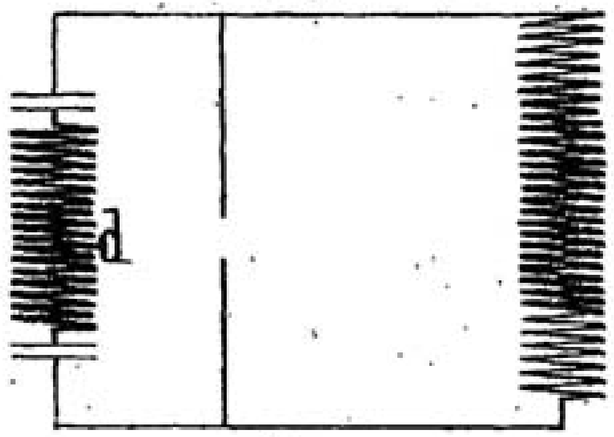


Fig. 5.

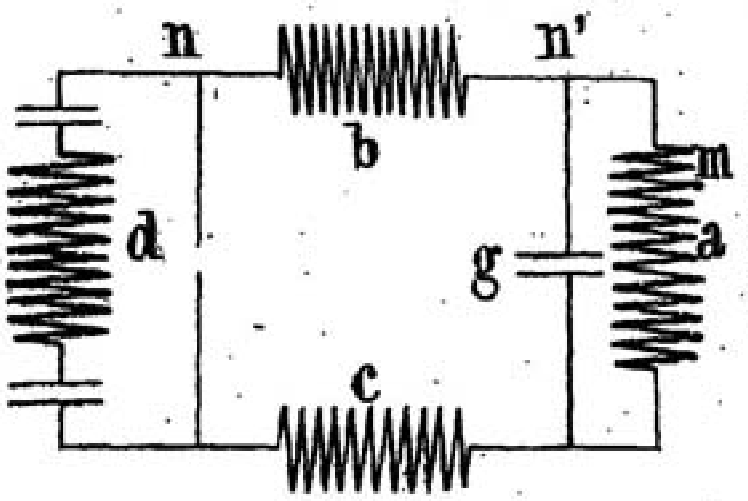


Fig. 2.

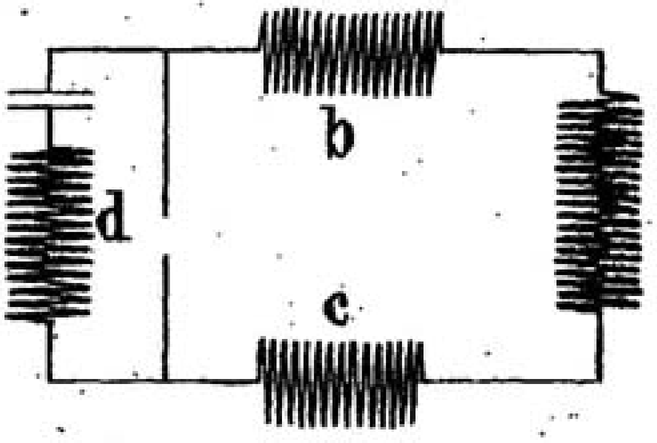


Fig. 3.

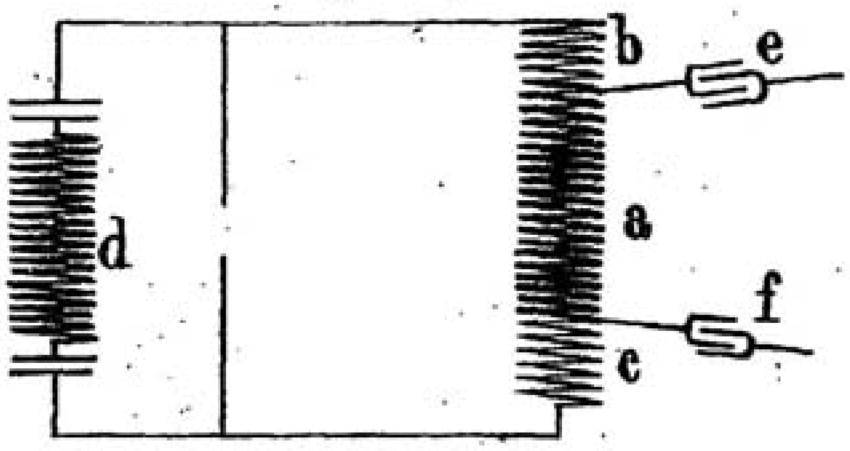
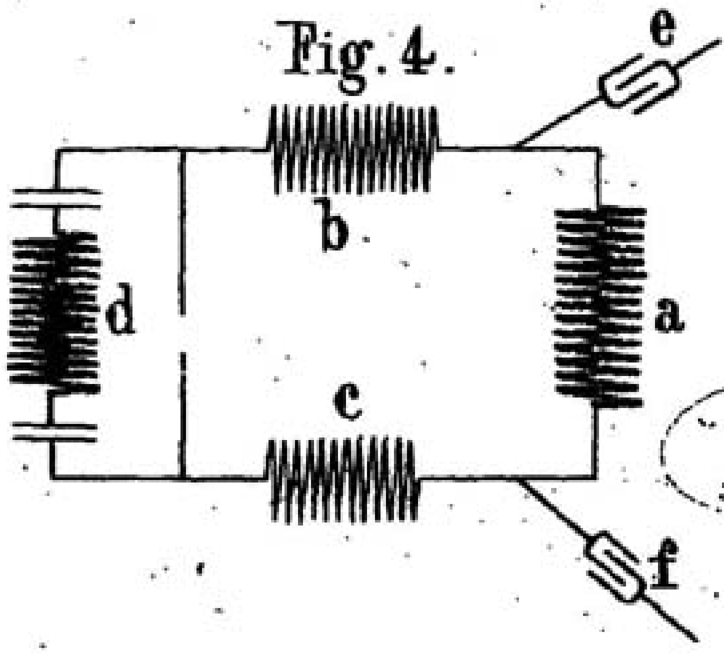


Fig. 4.



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N° 29,337 A.D. 1904

Date of Application, 31st Dec., 1904

Complete Specification Left, 27th Sept., 1905—Accepted, 16th Nov., 1905

PROVISIONAL SPECIFICATION.

"Method and Means for the Protection of Electrical Apparatus Branched on Circuits which are Traversed (Accidentally or otherwise) by Currents of High Frequency"

I, Georges Eugène Gaiffe of 9. Rue Méchain, Paris, France, Scientific Instrument Maker; do hereby declare the nature of this invention to be as follows.

When an installation giving rise (accidentally or otherwise) to oscillations of high frequency operates in the neighbourhood of electrical lines there are set up in these lines (which may or may not be in connection with the source of high frequency) induced currents which constitute a danger to apparatus fed by said lines. On this account accidents to the armature-windings of motors and dynamos are very liable to occur more especially (in the case of dynamos) if they directly feed the transformer or other winding which generates waves. Under these conditions sparks may in fact be observed either at the collector or even in the winding and these sparks are apt to produce short circuits in the winding. Furthermore it may be stated that a continuous current measuring-apparatus (such as a milli-ampèremeter) branched on the circuit of an X-ray tube for the purpose of measuring the quantity of electricity which traverses it, works normally so long as the current is continuous, or even if it be a current of low frequency, but that as soon as a discharge is produced in the circuit (which corresponds either to a scintillation of the tube or to a spark) and currents of high frequency are thereby set up in the circuit, in consequence of the self-induction of the windings of the measuring apparatus opposing itself to the passage of the high-frequency currents in the winding, sparking is seen to commence which if not remedied quickly renders the apparatus unserviceable.

The present invention relates to a protective device having for its object to remedy this danger.

This device is characterised by a special combination of two "resistanceless" impedance coils (*i.e.* of resistance small compared with their inductance) placed in circuit with the two conductors joining the winding of the apparatus to be protected to the main circuit for the purpose of artificially augmenting the natural impedance of this winding; and a capacity or condenser placed in shunt across the conductors feeding the current to the apparatus, in such manner that the current flowing in the line is able to charge the capacity or condenser without traversing the protective impedances. This arrangement has for effect to absorb the waves and prevent them from passing into the windings to be protected.

The annexed diagrams show by way of example a preferred arrangement of the protective device.

Referring to Figure 1 *a* is a condenser or a capacity connected in shunt across the terminals of the circuit of the apparatus A; *b*, b^1 are the impedance coils joined in series with the winding of the apparatus being respectively interposed between the ends of this winding and the terminals of the circuit which are connected with the line L, L^1 supplying the current and across which the condenser is shunted as above described.

The system thus constituted does not cause any perturbation in the flow of

[*Price* 8*d*.]

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continuous currents or alternating currents of low frequency traversing the line L, L^1.

The condenser does indeed become charged, but at low frequencies this requires but an infinitely feeble current. As regards the impedances b, b^1, their reactances are small at low frequencies and their resistances are negligible.

Hence the application of the protective device in no way modifies the regular working of the apparatus. But as soon as currents of high frequency arise the impedance coils b, b^1 prevent them from passing into the winding A., whilst the capacity or condenser *a* affords them a very easy passage; the apparatus A is not therefore exposed to the dangers mentioned above.

In the particular case of the protection of dynamos or measuring apparatus working in circuits feeding X-ray or other vacuum tubes, very satisfactory results may be obtained with a capacity or condenser whose value is of the order of a microfarad, and with impedance coils of very low values a dozen turns each, of copper wire of a diameter determined by the intensity of the current which circulates in the line L, L^1 will suffice.

This protective arrangement may be mounted on a board or contained in a box *c* as is shown in the diagram Figure 2. This board or box is furnished with two terminals d, d^1 to which are connected the conductors of the line L, L^1 and two terminals e, e^1 to which the apparatus A is connected. The present invention may be equally well applied to the protection of apparatus working in polyphase systems.

Figure 3 shows diagrammatically the application of the protective device to an apparatus working in a tri-phase circuit. A^1, A^2, A^3 are the three windings of the apparatus A taking the current, which it is desired to protect; L^1, L^2, L^3 are the feeders; a^1, a^2, a^3 the capacities or condensers; b^1, b^2, b^3 the protective impedance coils.

If one considers the circuit L^1 b^1 A^1 b^2 L^2 traversed by one of the phases one sees that the winding of the apparatus A is protected by the two impedances b^1, b^2 and the capacity a^1 under the same conditions as those obtaining above; similarly the windings A^2, A^3 which are traversed respectively by the two other phases are protected the one by the impedances b^2, b^3 and the capacity a^2, and the other by the impedances b^3, b^1 and the capacity a^3.

Dated this 31st day of December 1903.

A. M. & WM. CLARK,
Chartered Patent Agents,
53. Chancery Lane. London.

COMPLETE SPECIFICATION.

"Method and Means for the Protection of Electrical Apparatus Branched on Circuits which are Traversed (Accidentally or otherwise) by Currents of High Frequency".

I, GEORGES EUGÈNE GAIFFE of 9. Rue Méchain, Paris, France, Scientific Instrument Maker; do hereby declare the nature of this invention and in what manner the same is to be performed to be particularly described and ascertained in and by the following statement.

When an installation giving rise (accidentally or otherwise) to waves of high frequency operates in the neighbourhood of electrical lines there are set up in these lines (which may or may not be independent of the source of high frequency) induced currents which constitute a danger to apparatus fed by said lines. On this account accidents to the armature-windings of motors and dynamos are very liable to occur more especially (in the case of dynamos) if they directly feed the transformer or other winding which generates waves. Under these conditions sparks may in fact be observed either at the collector or even in the winding and these sparks are apt to produce short circuits in the winding. Furthermore it may be stated that a continuous current-measuring instrument (such as a milli-ampèremeter)—branched on the circuit of an X-ray tube for the purpose of measuring the quantity of electricity which traverses it—works normally only so long as the current is a continuous one, or at all events a current rectified at low frequency, but that as soon as a discharge is produced in the circuit (which corresponds either to a scintillation of the tube or to a spark) currents of high frequency are thereby set up in the circuit and in consequence of the self-induction of the windings of the measuring apparatus opposing itself to the passage of such high-frequency currents in the winding, sparking is seen to commence which if not remedied will quickly damage the apparatus.

The present invention relates to a protective device having for its object to annul this danger.

This device is characterised by a special combination of two "resistanceless" self-induction coils (*i.e.* of resistance small compared with their inductance) placed in the circuit of the two conductors joining the winding of the apparatus to be protected to the main circuit for the purpose of artificially augmenting the natural impedance of this winding; and a capacity or condenser placed in shunt across the conductors feeding the current to the apparatus, in such manner that the current flowing in the line is able to charge the capacity or condenser without traversing the protective self-induction coils. This arrangement has for effect to absorb the waves and prevent them from traversing the windings which it is desired to protect.

The diagrams annexed to the Provisional Specification show by way of example a preferred arrangement of the protective device.

Referring to Figure 1, *a* is a condenser or a capacity connected in shunt across the terminals of the circuit of the apparatus A; *b* b^1 are the self-induction coils joined in series with the winding of the apparatus being respectively interposed between the extremities of this winding and the terminals of the circuit which are connected with the line L L^1 supplying the current and across which the condenser is shunted as above described.

The system thus constituted does not cause any appreciable perturbation in the flow of continuous currents or alternating currents of low frequency traversing the line L L^1.

The condenser does indeed become charged, but at low frequencies, this requiring but an infinitely feeble current. As regards the self-induction coils *b* b^1, their reactances are small at low frequencies and their resistances are negligible.

Hence the application of the protective device in no way vitiates the regular working of the apparatus. But as soon as currents of high frequency arise the self-induction coils *b* b^1 prevent them from passing into the winding A, whilst the capacity or condenser *a* affords them a very easy passage; the apparatus A is not therefore exposed to the dangers mentioned above.

In the particular case of the protection of dynamos or measuring apparatus working in circuits feeding X-ray or other vacuum tubes, very satisfactory results may be obtained with a capacity or condenser whose value is of the order of a microfarad, and with self-induction coils *b* b^1 of very low values; a dozen turns each, of copper wire of a diameter determined by the intensity of the current which circulates in the line L L^1, will suffice.

This protective arrangement may be mounted on a board or contained in a box *c* as is shown in the diagram Figure 2. This board or box is furnished with two terminals d, d^1 to which are connected the conductors of the line $L\ L^1$ and two terminals $e\ e^1$ to which the apparatus A is connected. The present invention may be equally well applied to the protection of apparatus working in polyphase systems.

Figure 3 shows diagrammatically the application of the protective device to an apparatus working in a tri-phase circuit. $A^1\ A^2\ A^3$ are the three windings of the apparatus A in use, which it is to protect; $L^1\ L^2\ L^3$ are the feeders; $a^1\ a^2\ a^3$ the capacities or condensers; $b^1\ b^2\ b^3$ the protective self-induction coils.

If one considers the circuit $L^1\ b^1\ A^1, b^2\ L^2$ traversed by one of the phases one sees that the winding A^1 of the apparatus A is protected by the two self-induction coils $b^1\ b^2$ and the capacity a^1 under the same conditions as those obtaining in the above described arrangement; similarly the windings $A^2\ A^3$ which are traversed respectively by the two other phases are protected the one by the self-induction coils $b^2\ b^3$ and the capacity a^2 and the other by the self-induction coils $b^3\ b^1$ and the capacity a^3.

Having now particularly described and ascertained the nature of the said invention and in what manner the same is to be performed, I declare that what I claim is.

A protective device for electrical apparatus connected in circuits which are liable to be traversed (accidentally or not) by currents of high frequency, consisting essentially in the combination of self-induction coils interposed in the circuit of the conductors which convey the current to the apparatus to be protected, with capacities or condensers connected in shunt across the conductors conveying the current to said apparatus in such manner that the current flowing in the line may charge the condenser or condensers without having to traverse the said protective self-induction coils, substantially as specified.

Dated this 27th day of September 1905.

A. M. & WM. CLARK,
Chartered Patent Agents,
53, Chancery Lane, London.

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Note.—*The application for a Patent has become void, and the Specification is published in accordance with the provisions of the Patents Act,* 1901.
This print shows the Specification as it became open to public inspection.

N° 2624 A.D. 1906

(Under International Convention.)

Date claimed under Patents Act, 1901, being date of first Foreign Application (in France), } *8th Apr., 1905*

Date of Application (in the United Kingdom), 2nd Feb., 1906

At the expiration of twelve months from the date of the first Foreign Application, the provision of Section 1 (2) of the Patents Act, 1901, as to inspection of Specification, became operative

Complete Specification not accepted

COMPLETE SPECIFICATION.

"Improvements in Automatic Mercury Interrupters".

I, Georges Eugène Gaiffe of 9. Rue Méchain, Paris, France, Scientific Instrument Maker; do hereby declare the nature of this invention and in what manner the same is to be performed to be particularly described and ascertained in and by the following statement.

The rotary mercury interrupters at present in use are actuated by independent motors even when the motor is keyed directly to the shaft, the motor circuit being independent of the interrupter circuit and of the induction coil circuit.

This invention relates to an automatic mercury interrupter wherein the motor circuit is wound either in series or in shunt with the induction coil circuit, and wherein the intermittent closure of the motor circuit and of the coil circuit is produced by a single interrupter.

This novel combination constitutes an automatic interrupter which possesses the advantage over those now in use of permitting of the employment of a motor having a very simple winding and of only necessitating the employment of a single interrupter which may work in petrol, alcohol or even in water and which, consequently yields excellent results.

The accompanying drawing shows by way of example, a method of carrying out the invention in practice.

Figure 1 is an elevation of the interrupter partly in section, Figure 2 being a plan thereof, and Figure 3 a horizontal section on line A—A Figure 1. Figure 4 is a schematic view showing the connections when the motor circuit is wound in series with the induction coil circuit, and Figure 5 is a similar view showing the connections when the motor circuit is wound in shunt with the coil circuit.

Figure 6 shows a particular construction of the toothed ring forming a portion of the improved interrupter, while Figure 7 is a schematic view of the development of the same.

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combination, a cabinet having a front wall with a control panel therein and a removable back wall, said control panel having a plurality of openings therein, an oscillator unit having patient's terminals projecting forwardly therefrom, means for supporting and guiding said unit for movement through the back of said cabinet forwardly toward said panel to register said terminals each with one of said openings, transforming and rectifying means mounted within said cabinet, and means for establishing operative connection between said transforming and rectifying means and said unit.

10. High frequency apparatus comprising, in combination, a cabinet having a fixed front panel and a rear wall movable to open the rear side of the cabinet, transforming and rectifying means mounted in said cabinet, a power supply circuit including a switch biased to open position connected to said means, power output terminals leading from said means, an oscillator unit adapted to be removably positioned in an operating position within said cabinet and having input terminals, means carried by said oscillator unit adapted to connect said input and said output terminals when said oscillator unit is positioned within said cabinet, and means on said rear wall cooperating with said switch and adapted to close the same to render the apparatus operative upon moving the wall to closed position.

HERMAN O. FISCHER.

Patented May 25, 1926. **1,585,970**

UNITED STATES PATENT OFFICE.

HERMAN G. FISCHER, OF CHICAGO, ILLINOIS, ASSIGNOR TO H. G. FISCHER COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

INDIRECT FULGURATION ELECTRODE.

Application filed May 21, 1923. Serial No. 640,322.

The present invention relates to an improvement in electrodes adapted to be employed in the therapeutic use of low voltage high frequency electrical currents by the fulguration process, which has now become a common one in the application of electrical treatments to the human body.

The device of the invention may be generally referred to as a finger rheostat, inasmuch as it contemplates the control of electrical current by simple manipulation of the fingers of the physician, or other user, though it will be understood that, from certain aspects, the invention may be of broader scope than might be indicated by this designation.

In order that the use of this device may be clearly understood, it should be known that the process of treatment contemplated is the indirect method in which the patient may be positioned on an auto-condensation pad, to which current is supplied from a high frequency apparatus of any desired form. The current with which the body is charged may then be withdrawn at the point of application of the electrode.

A principal object of this invention is the provision of a controlling device adapted for simple manipulation to control the amount of current withdrawn from the body.

Other objects and advantages of the invention will be apparent as it is better understood from the following description, which, taken in connection with the accompanying drawings, discloses a preferred embodiment thereof.

Referring to the drawings,

Figure 1 is a perspective view of a device in which my invention is embodied, illustrating the method of control;

Fig. 2 is a plan view of the insulated control member, showing the means whereby it is connected to the fulguration point; and

Fig. 3 is a longitudinal section of the parts shown in Fig. 2.

As thus illustrated, the electrode of my invention comprises a fulguration point 21, which is held in an insulated handle 22 and connected by a wire 23 with a controlling device generally indicated by the reference character 24. Said device comprises a current conducting plate, or bar, 25, which may be of German silver, or other suitable material, and is embedded in an insulating hand piece 26, which latter has inserted therein, from one end, a rod 27 contacting at one end with the wire 23 and being connected with the bar 25 by means of screws 28, which serve at once to hold said bar 25 in place and to establish electrical connection with the rod 27.

The wire 23 is enclosed in a tube 29, which may be of rubber, or other suitable material, as also may the hand-piece 22. The hand-piece 26 is provided with a recess 31 at one end to receive the tube 29 and it will be noted that the wire 23, extending through the tube at this end, enters the body of the rod 27, as shown at 32. A projection 33, at one end of said hand-piece, is slotted at 34 and the other end of the hand-piece is slotted at 35 to receive an elastic band, or strap, 36, by which said hand-piece may be held on the hand of the user, in the position shown in Fig. 1.

With said hand-piece positioned as shown, the bar 25 may be engaged by one or more of the fingers of the hand of the user, which latter is indicated by the reference character 37. Thus more or less resistance is provided to control the current drawn by the fulguration point 21, it being understood that said current is grounded through the body of the physician, or other user of the device.

A suitable insulating support may be provided for the right hand which engages the handle 22 and the physician may concentrate his attention upon said point while controlling the operation by simply manipulating the fingers of his other hand.

It is thought that the invention and many of its attendant advantages will be understood from the foregoing description, and it will be apparent that various changes may be made in the form, construction and arrangement of the parts without departing from the spirit and scope of the invention, or sacrificing all of its material advantages, the form hereinbefore described being merely a preferred embodiment thereof.

I claim:

1. An indirect fulguration electrode, comprising a fulguration point adapted to be held adjacent the body of a patient subjected to electrical current, and a control connected with said point, said control being adapted to be held in the hand of the user and manipulated by contact of one or more

fingers therewith to vary the amount of current drawn from the patient.

2. An indirect fulguration electrode, comprising a fulguration point adapted to be held adjacent the body of a patient subjected to electrical current, and a control comprising an insulated current conducting member connected with said point and adapted to be engaged by one or more fingers of the user to vary the amount of current drawn from the patient.

3. An indirect fulguration electrode, comprising a fulguration point adapted to be held adjacent the body of a patient subjected to electrical current, and a control comprising an insulated current conducting member adapted to be secured to the hand of the user and connected with said fulguration point whereby the amount of current drawn from the patient may be varied in accordance with the extent of contact made by one or more of the user's fingers.

4. An indirect fulguration electrode, comprising a fulguration point, an insulating handle by which said point may be held in position adjacent a part to be treated on the body of a patient subjected to electrical current, and a control connected with said point and adapted to have more or less resistance put in circuit therewith by the progressive removal of the operator's fingers whereby to vary the amount of current drawn from the patient.

5. An indirect fulguration electrode, comprising a fulguration point, an insulating handle by which said point may be held in position adjacent a part to be treated on the body of a patient subjected to electrical current, and a control connected with said point and adapted to have more or less resistance applied thereto whereby to vary the amount of current drawn from the patient, said handle being adapted to be held in one hand of the user and said control being adapted to be held in the other hand and manipulated by engagement of one or more fingers therewith.

HERMAN G. FISCHER.

Feb. 1, 1927.

1,616,277

H. H. OSBORN

ELECTRIC SWITCH

Filed July 17, 1922

2 Sheets-Sheet 1

Fig. 1

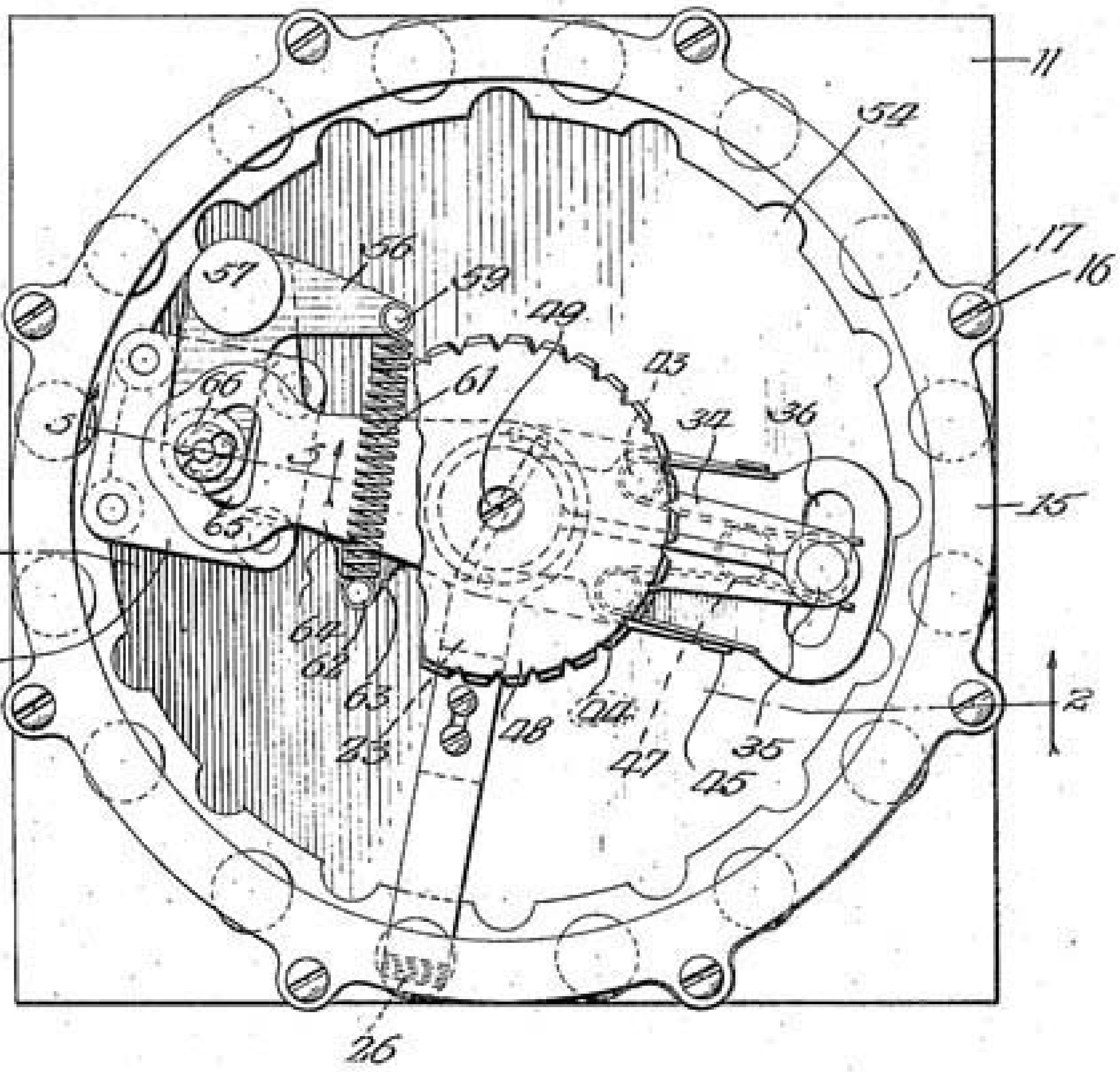
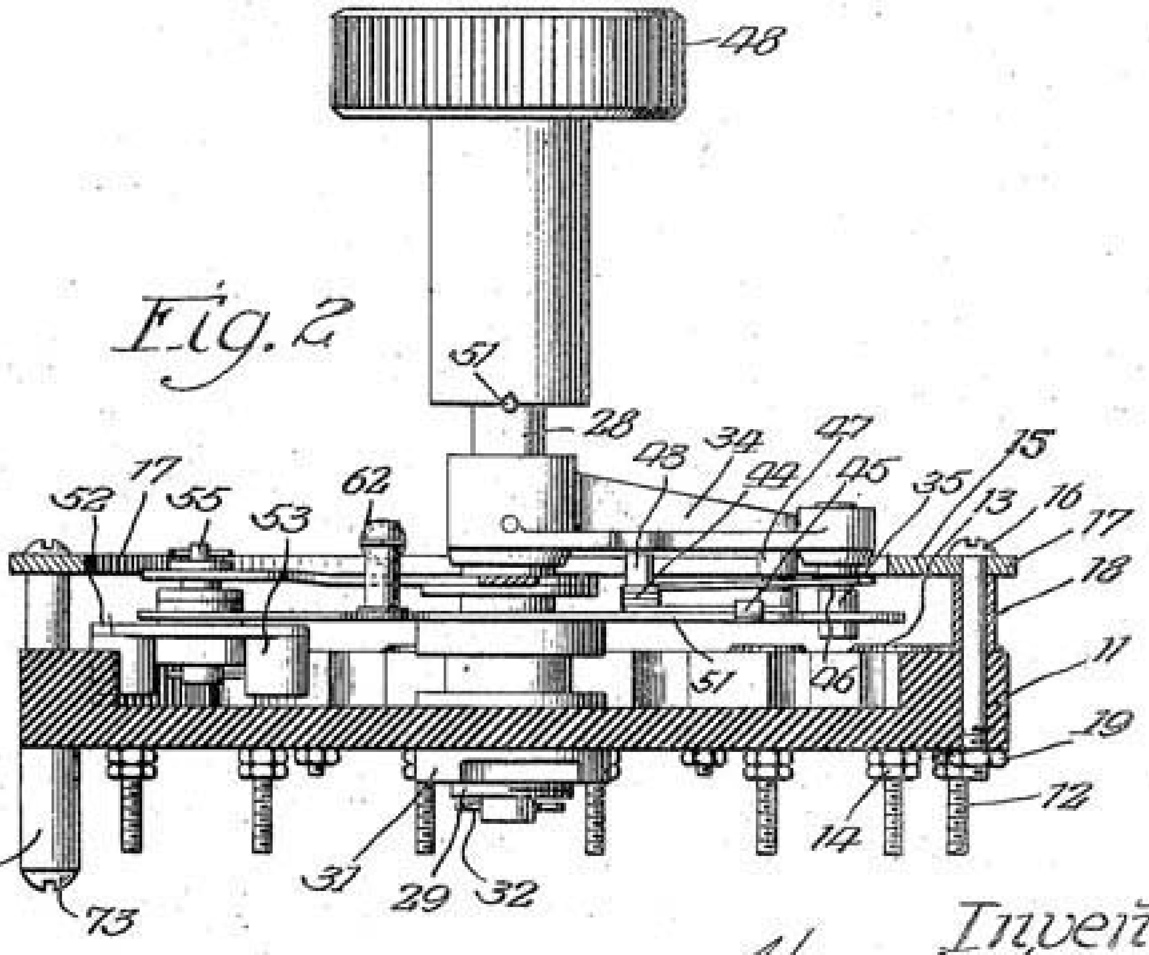


Fig. 2



Inventor
Howard H. Osborn
By:-Munday, Clarke & Carpenter

Feb. 1, 1927. **1,616,277**

H. H. OSBORN

ELECTRIC SWITCH

Filed July 17, 1922 2 Sheets-Sheet 2

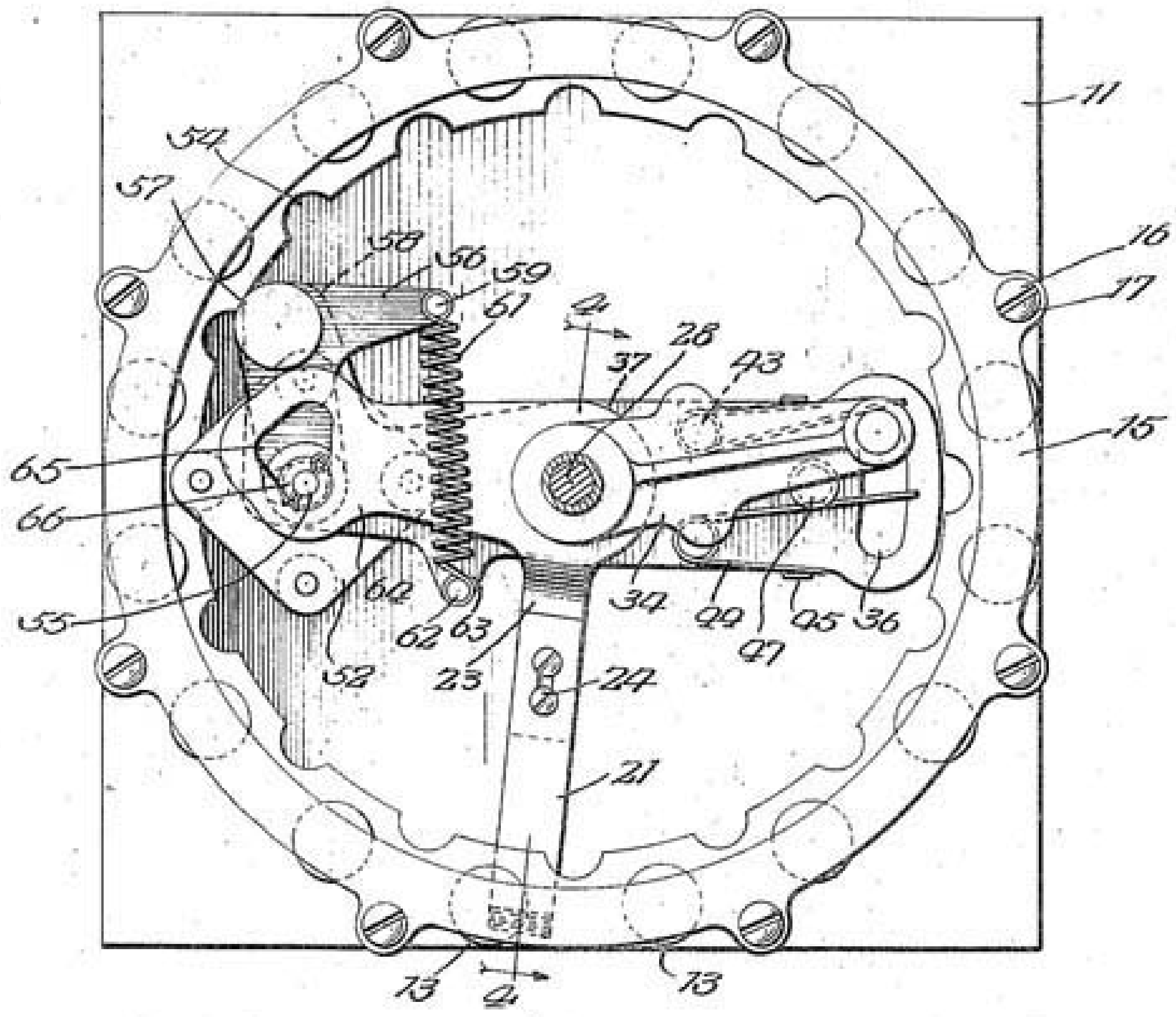


Fig. 3

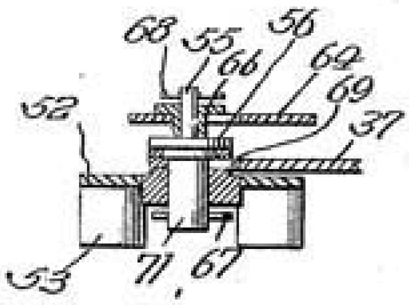
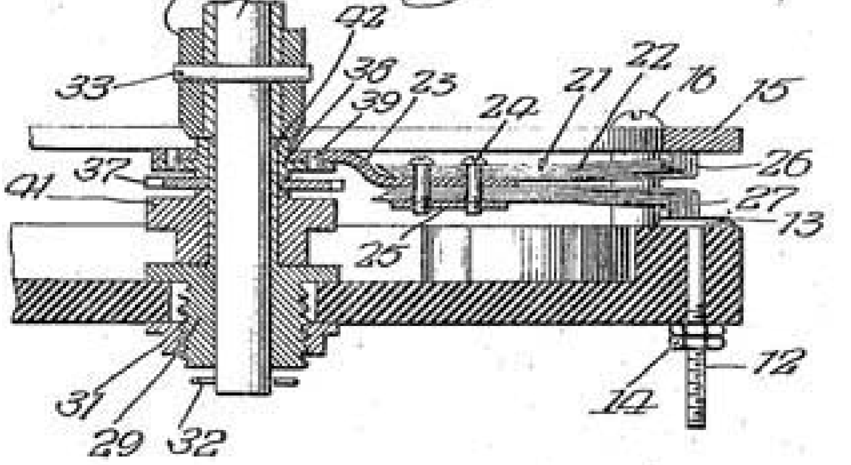


Fig. 5

Fig. 4



Inventor
Howard H. Osborn
By:- Munday, Clarke & Carpenter
Att'ys.

Patented Feb. 1, 1927. **1,616,277**

UNITED STATES PATENT OFFICE.

HOWARD H. OSBORN, OF CHICAGO, ILLINOIS, ASSIGNOR TO H. G. FISCHER & CO., OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

ELECTRIC SWITCH.

Application filed July 17, 1922. Serial No. 575,444.

This invention relates in general to electric switches, and refers more particularly to means for positively and sharply throwing a switch blade from one button to another, and for positively locking said blade in contact with any button to which it is turned.

A principal object of the invention is the provision of an improved type of switch operable without likelihood of the blade sticking at any point and without likelihood of incomplete movement which would leave it in inoperative position.

A further object of the invention is the provision of a switch of this character provided with means for positively holding the blade in any of its predetermined positions and requiring special and considerable effort to move it from locked position, thus insuring against accidental throwing of the switch and inexact operation thereof.

A still further object of the invention is the provision of switch operating mechanism of the positive character described, operable with equal facility in either direction, and without limit to its movement.

Another and highly important object of the invention is the provision, in an electric switch construction, of locking means movable in its operation past center relatively to the point upon which it operates without appreciable movement of the blade carrying mechanism, and of spring means tensioned by such movement so as to subsequently throw the blade sharply from one of its contact points to another.

One of the particular objects of the invention is the provision of a slot and roll connection between the blade carrying mechanism and the throwing and locking mechanisms which permits accomplishment of the objects above stated.

Numerous other objects and advantages of the invention will be apparent as it is better understood from the following description, which, taken in connection with the accompanying drawings, discloses a preferred embodiment thereof.

Referring to the drawings,

Figure 1 is a top plan view of a switch embodying the principles of my invention;

Fig. 2 is a vertical sectional view taken substantially on the line 2—2 of Fig. 1;

Figure 3 is a plan view similar to that of Fig. 1, the parts being shown in different position and omitting the operating knob;

Fig. 4 is a detail section taken substantially on the line 4—4 of Fig. 3; and

Fig. 5 is a detail section taken substantially on the line 5—5 in Fig. 1.

Upon the drawings illustrating my invention I have shown an insulated base member 11, adapted for attachment to a suitable part of the apparatus with which it is to be employed, and having a plurality of posts 12 extending therethrough and forming spaced apart contact points or buttons 13 about the periphery of the plate 11. It will be understood that electric wires may be secured to these points by means of nuts 14 and the posts may be provided in any desired number according to particular requirements. The current conducting upper contact ring 15 is secured to the plate by means of screws 16 extending through projections 17 therein and through the plate 11, collars 18 being provided between said ring and said plate to maintain the spaced relationship thereof and nuts 19 being fitted onto the inner ends of said screws 16. A blade 21 consisting of a plurality of copper leaves 22 arranged in upper and lower groups and secured to a supporting arm 23 by means of screws 24 and a block 25 are provided with oppositely turned ends 26 and 27 adapted to contact respectively with the ring 15 and the contact buttons 13. The arm 23 is secured to a shaft 28 extending through a shouldered and externally threaded sleeve or block 29, a nut 31 being secured onto the block 29 and a cotter pin 32 holding the shaft against vertical movement. The shaft 28 has secured thereto by a pin 33 a lever 34 carrying at its outer end a depending post or pin 35 engaging in a slot 36 in a centrally pivoted lever 37. Both the arm 23 and the lever 37 are rotatable upon the shaft 28, the arm 23 being secured to a collar 38 by pins 39 and the lever 37 being carried between said collar and a larger collar 41 therebeneath, a sleeve 42 upon the shaft forming a bearing surface for these last mentioned parts.

Upon the lever 37 are two posts 43 upon which are positioned two wire springs 44 having ends engaged behind lugs 45, opposite and longer ends engaging in grooves 46 in the pin 35. A grooved central post 47 extends upwardly from the lever 37 and just behind the pin 35 when the latter is centered in the slot 36, the purpose of this post being to prevent movement of either of the springs past center, thus assisting in centering the lever 34.

A hand wheel or knob 48 is secured by a screw 49 and a pin 51 to the shaft 28, and operation thereof actuates the lever 34. The pin 35 upon reaching the end of the slot 36 actuates the lever 37 about the shaft 28 and through the instrumentality of this last mentioned lever the switch blade is thrown in a manner to be now described.

A rectangular locking member 52 is provided at its corners with depending pins 53 engageable in pairs in recesses 54 provided in the wall of a central depression in the material of the plate 11. This member is carried on a pin 55 upon which also the end of the lever 37 is pivoted and a bell crank lever 56 has one end loosely connected with said pin and is pivoted at 57 onto a projection 58 of the lever 37, the opposite end of said bell crank being provided with an upstanding post 59 to which is secured one end of a spring 61 having its opposite end connected to a post 62 upstanding from a projection 63 on the opposite side of the lever 37. The arm 23 has an extension 64 provided with a triangular slot 65 into which extends a roller 66 rotatably secured upon the pin 55, all said parts being held upon the pin 55 by cotter pins 67 and 68.

The lever 37 is provided with a slot 69 engaging a sleeve 71 on the pin 55 and actuation of said lever 37 by the lever 34 moves said pin 55 and the roller 66 and sleeve 71 from the positions shown in Fig. 1 to those shown in Fig. 3, at the same time turning the locking member 52 and drawing inwardly the inner arm of the bell crank lever 56. It will be observed that through the operation of the roller 66 in the slot 65 the movement to the position shown in Fig. 3 may be accomplished without appreciable movement of the arm 23 and such movement tensions the spring 61. After the member 52 has turned past center of the pivot provided by one of the depending pins 53 engaging in one of the recesses 54 its movement will be sharply completed and the spring 61 serves to throw the arm 23 to the next button 13. In this manner the blade 21 is caused to maintain its contact with one button until the actuating parts just described have been positively moved to the position from which, by reason of the construction which I have provided, they throw said blade to the next adjacent button. The balance and pressure of the parts in operation are such as to prevent an incomplete movement, since the spring 61 and the shape of the member 52 practically necessitate engagement of two of the pins 53 in the recesses 54. The spring 44, it will be noted, serves to assist in bringing the parts to the position of Fig. 3, and the spring 61 completes the movement after the member 52 has moved past center.

Current is communicated to the ring 15 by means of a post contained in the sleeve 72 and extending through the plate 11, a screw 73 being inserted in the lower end of said sleeve to hold an electric wire in contact therewith. The operation of my switch practically insures completion of a circuit between said ring and one of the buttons 13 at all times and it is believed that the efficiency of the mechanism which I have provided will be manifest.

It is thought that the invention and many of its attendant advantages will be understood from the foregoing description, and it will be apparent that various changes may be made in the form, construction and arrangement of the parts without departing from the spirit and scope of the invention or sacificing all of its material advantages, the form hereinbefore described being merely a preferred embodiment thereof.

I claim:

1. An electric switch, comprising a base, a plurality of contact buttons in said base, a current conducting member spaced from said buttons, a switch blade adapted to communicate current from said member to one of the buttons, and operating mechanism for said blade comprising a rectangular locking member engaged at its corners in interior peripheral recesses in said base and means for moving said member about one of said recesses as a fulcrum point with preliminary motion not appreciably affecting said blade and final motion exerting a sharp throwing action upon the blade to move it from one of said buttons to another.

2. An electric switch, comprising a base, a plurality of contact buttons in said base, a current conducting member spaced from said buttons, a switch blade adapted to communicate current from said member to one of the buttons, and operating mechanism for said blade comprising a pivoted locking member having parts engageable in recesses spaced about the wall of a depression in said base, a slotted arm carrying said blade, and means including a roll operable in the slot of said arm for moving said locking member about said wall with preliminary motion not appreciably affecting said blade and final motion exerting a sharp throwing action upon the blade to move it from one of said buttons to another.

3. An electric switch, comprising a base, a plurality of contact buttons in said base, a current conducting member spaced from said buttons, a switch blade adapted to communicate current from said member to one to the buttons, and operating mechanism

for said blade comprising a pivoted locking member having parts engageable in recesses spaced about the wall of a depression in said base, a slotted arm carrying said blade, means including a roll operable in the slot of said arm for moving said locking member about said wall, and spring tensioned means for moving said arm with a sharp throwing action upon completion of the movement of said roll in said slot.

4. An electric switch, comprising a base, a plurality of contact buttons in said base, a current conducting member spaced from said buttons, a switch blade adapted to communicate current from said member to one to the buttons, and operating mechanism for said blade comprising a manually operable shaft upon which the blade is pivoted, a rigid operating arm extending from said shaft, a slotted lever operable by said rigid arm and movable a distance independently of said blade, a locking member operable by said lever and connections between said lever and said blade causing quick movement of the latter from one button to another after partial rotary movement of said locking member.

5. An electric switch, comprising a base, a plurality of contact buttons in said base, a current conducting member spaced from said buttons, a switch blade adapted to communicate current from said member to one of the buttons, and operating mechanism for said blade comprising a locking member, actuating means for said member and said blade, and a roll and slot connection between said means and said blade whereby said locking member may be partially moved by said means prior to actuation of the blade.

6. An electric switch, comprising a base, a plurality of contact buttons in said base, a current conducting member spaced from said buttons, a switch blade adapted to communicate current from said member to one to the buttons, and operating mechanism for said blade comprising a locking member, actuating means for said member and said blade, a roll and slot connection between said means and said blade whereby said locking member may be partially moved by said means prior to actuation of the blade, and spring means for thereafter sharply throwing said blade.

7. A control switch for electrical apparatus, comprising, a base, a plurality of contact buttons in said base, a current conducting member secured to said base and spaced from said contact buttons, a control shaft rotatably secured to said base having an operating handle and a switch operating arm secured thereto, a switch blade for transmitting current from said current conducting member to one of said contact buttons pivotally secured to said control shaft, and means interposed between said control shaft operating arm and the switch blade and arranged for rolling contact with the arm for controlling the movement of said switch blade.

8. A control switch for electrical apparatus, comprising, a base, a plurality of contact buttons in said base, a current conducting member secured to said base and spaced from said contact buttons, a control shaft rotatably secured to said base having an operating handle and a switch operating arm secured thereto, a switch blade for transmitting current from said current conducting member to one of said buttons pivotally secured to said control shaft, and means pivoted on said control shaft and engaging said operating arm and the switch blade for causing intermittent motion of the switch blade.

9. A control switch for electrical apparatus, comprising, a base, a plurality of contact buttons in said base, a current conducting member secured to said base and spaced from said buttons, a control shaft rotatably secured to said base having an operating handle and a switch operating arm secured thereto, a switch blade for transmitting current from said current conducting member to one of said buttons pivotally secured to said control shaft, and means connecting said switch control arm and switch blade for controlling the movement of the switch blade, said means, comprising, a lever pivoted intermediate its ends to the operating shaft and yieldably engaging the switch operating arm at one end, and means pivoted to the other end of said lever engaging in a slotted portion of said switch blade and in recesses in the body.

10. A control switch for electrical apparatus, comprising, a base, a plurality of contact buttons in said base, a current conducting member secured to said base and spaced from said contact buttons, a control shaft rotatably secured to said base having an operating handle and a switch operating arm secured thereto, a switch blade for transmitting current from said current conducting member to one of said contact buttons pivotally secured to said control shaft, and means pivoted on said control shaft and interposed between the control shaft operating arm and the switch blade for controlling the movement of the switch blade, said means including a rotatable device having rolling contact with the base.

HOWARD H. OSBORN.

July 5, 1927.

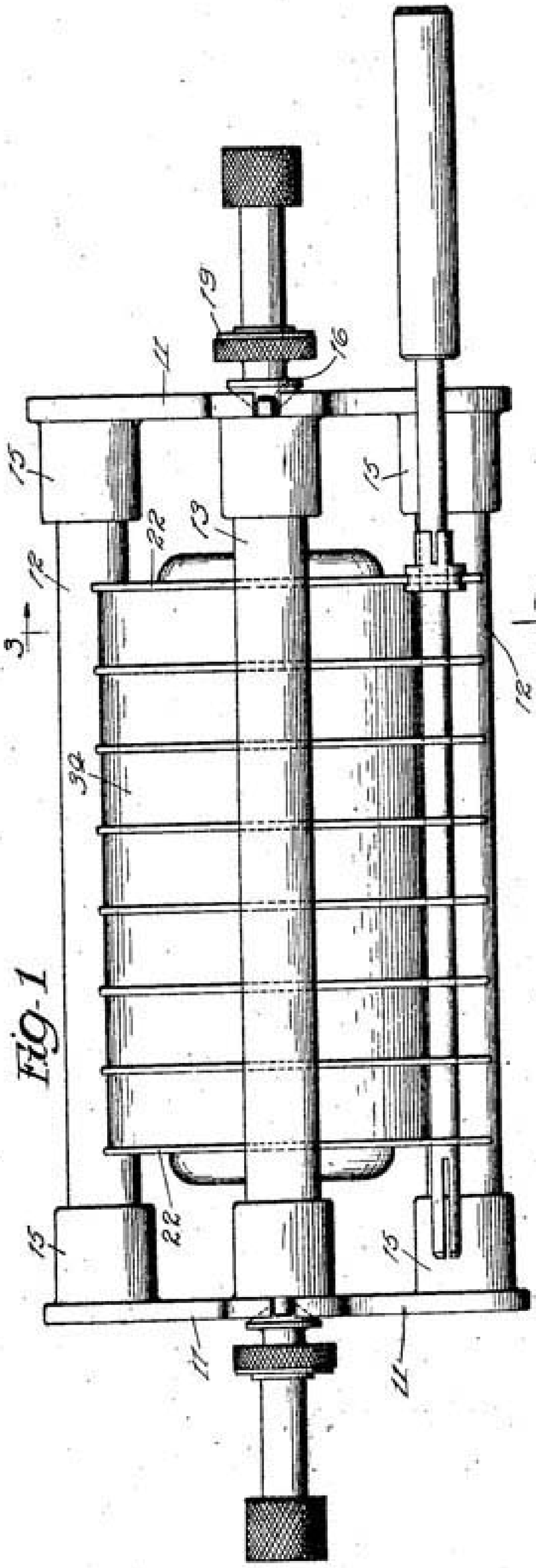
H. H. OSBORN

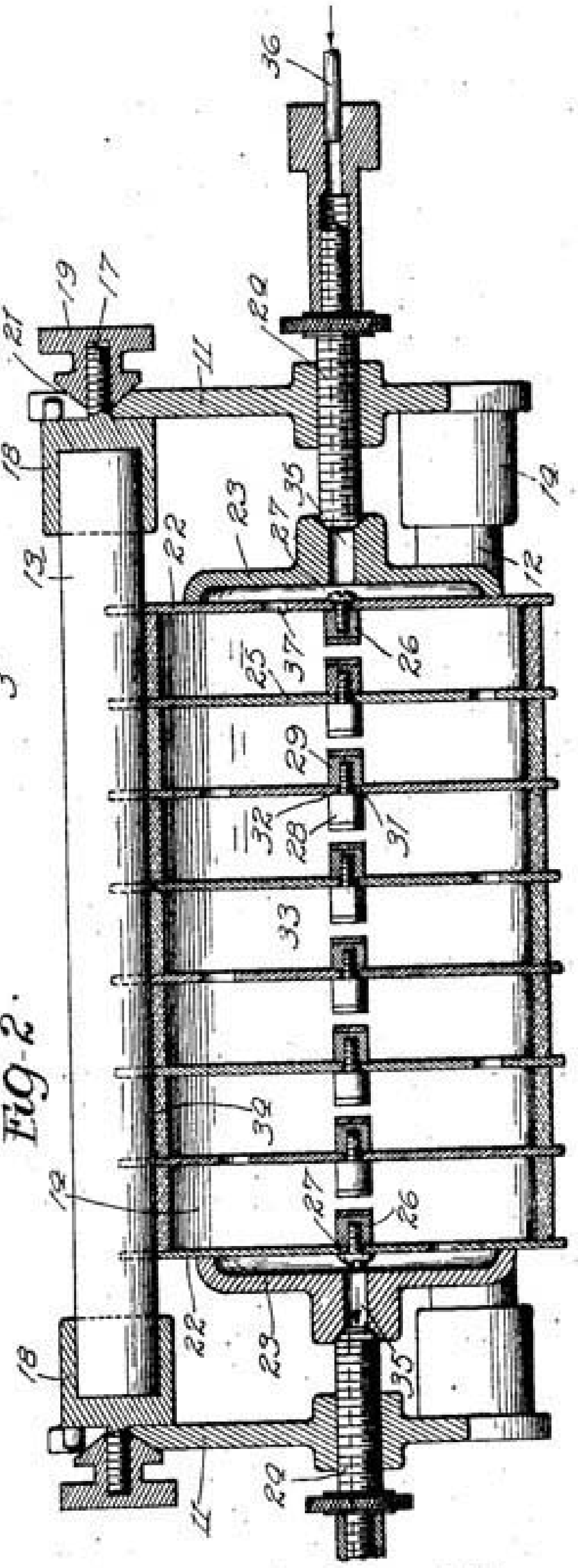
1,634,627

SPARK GAP

Filed June 10, 1921

2 Sheets-Sheet 1





Inventor:
Howard H. Osborn
By: Munday, Clarke & Carpenter
Attys.

July 5, 1927.

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1,634,627

SPARK GAP

Filed June 10, 1921

2 Sheets-Sheet 2

Fig-3

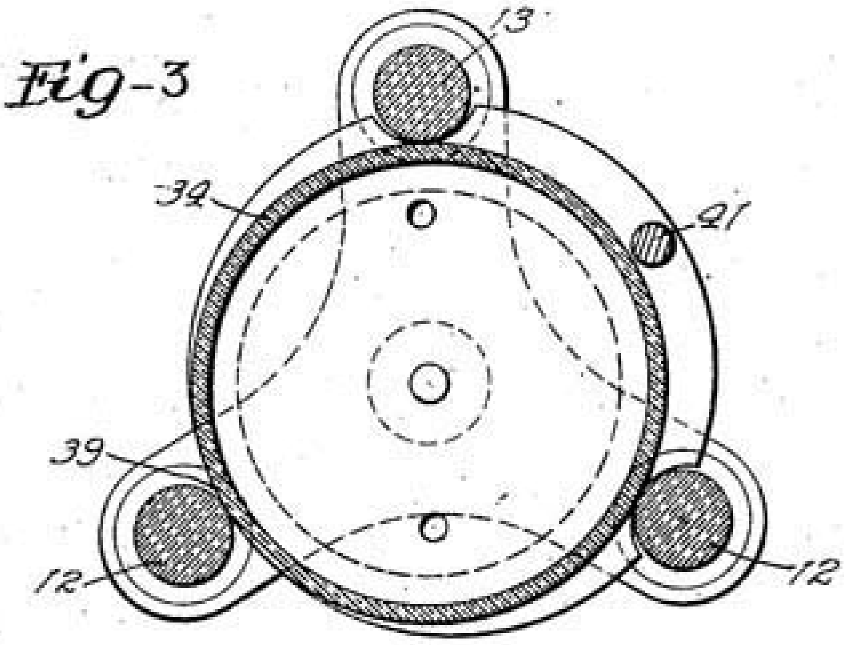


Fig-4

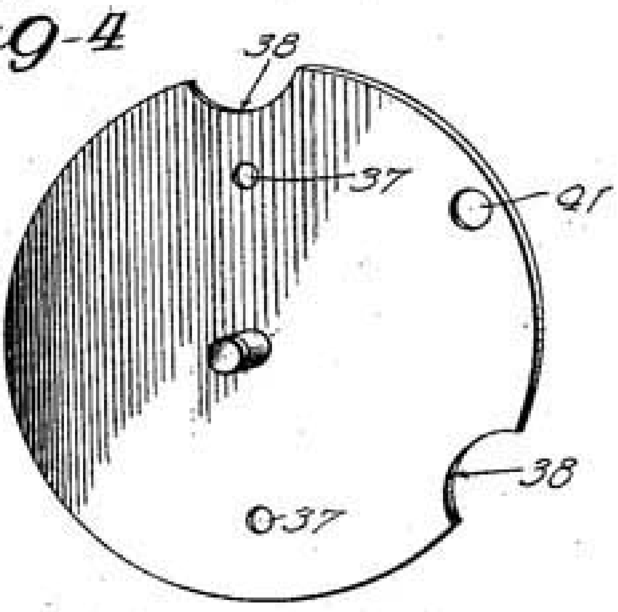


Fig-5

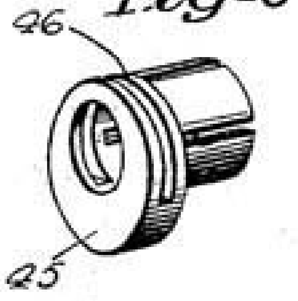
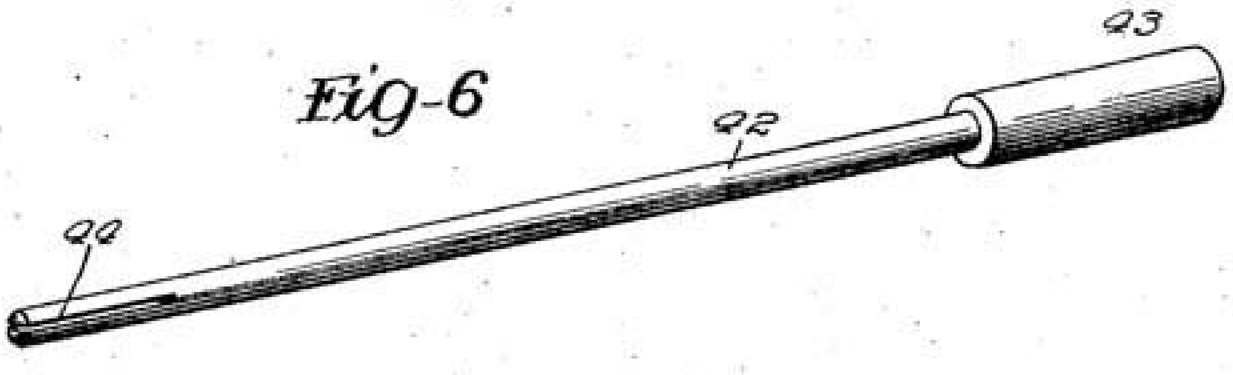


Fig-6



Inventor
Howard H. Osborn
By:- Munday, Clarke & Carpenter, Atty's

Patented July 5, 1927. **1,634,627**

UNITED STATES PATENT OFFICE.

HOWARD H. OSBORN, OF CHICAGO, ILLINOIS, ASSIGNOR TO H. G. FISCHER & COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

SPARK GAP.

Application filed June 10, 1921. Serial No. 476,640.

This invention relates in general to apparatus for generating electric current of high frequency and voltage, and has more particular reference to spark gaps employed in such apparatus, the particular embodiment of the invention to be hereafter described being of that character comprising a part of the electro-therapeutic equipment employed by physicians.

A principal object of the invention is the provision of a simplified and highly efficient spark gap dispensing with certain elements of construction heretofore deemed essential, and being susceptible of comparatively inexpensive commercial production.

My invention also contemplates the provision in a device of the character described of parts particularly adapted for the purposes heretofore stated and at the same time serving to muffle the sound and to dim or modify the light resultant from the sparks at the gaps.

A still further object of the invention is the provision of a sparking device having the above characteristics in combination with means for ventilating the cells formed by the multiple gaps, and with means for varying the length of the spark by rendering inoperative one or more individual gaps.

Numerous other objects and advantages of the invention will be apparent as it is better understood from the following description, which, taken in connection with the accompanying drawings, discloses a preferred embodiment thereof.

Referring to the drawings:

Figure 1 is a plan view of a multiple spark gap embodying the principles of my invention;

Fig. 2 is a longitudinal vertical section through the same;

Fig. 3 is a section taken transversely of the device;

Fig. 4 is a perspective of one of the conductive disks;

Fig. 5 is an enlarged view of the bushing through which the short circuiting rod extends; and

Fig. 6 is a perspective of the short circuiting rod.

The embodiment of my invention, shown by way of illustration in the drawings, comprises primarily a pair of end holding plates 11, three glass connecting rods, 12, 13, extending therebetween, and a series of sparking cells indicated generally by the reference character 14. Upon the end plates 11 are appropriate sockets 15 for the glass connectors 12. In the upper parts of these plates are slots 16 for the reception of screw threaded projections 17 of sockets 18 in which the third glass connector 13 is retained. The material about the lower part of the slots 16 is beveled, and nuts 19 having pointed or beveled noses 21 are provided and adapted to be screwed upon the projections 17 and into the beveled portion of the plate to hold the top connector in place. In this manner the connector 13 is rendered removable in order to permit the taking apart and removal of the several parts of the device.

At opposite ends of the series of sparking cells are disks 22 against which end clamps 23 are pressed by means of screw posts 24 extending through the plates 11, and by means of which the entire series of sparking cells is pressed tightly together and held in place. The screw posts 24, in the present instance, constitute also binding posts with which the wires of the circuit may be connected to include the sparking device therein. The sparking cells are formed by the disks 22 and similar disks 25 arranged in series through the device. The disks 22 are provided with studs 26 secured thereto by means of screws 27 and extending inwardly. Each disk 25 is equipped with oppositely extending studs or units 28 and 29 which are secured together by means of screws 31 extending through apertures 32 in the central portions of the disks, the gaps 33 being provided between the opposed studs or units 26, 28 and 29. The electric current is passed through the binding posts 24, the disks 22 and 25, these being formed of conductive material, and through the studs or units 26, 28 and 29, the sparks occurring at the gaps 33.

Housings or encasing members 34 are provided between the disks 22, 25 and are formed of insulating material in order that the electric current may be directed through the sparking elements hereinbefore described. In the present instance these housings or encasing members are cylindrical in form and composed of glass which is exteriorly ground in order to dim or modify the light from the sparks. It will be seen that each of these members encloses one sparking gap and that the cells are formed merely by the use of the conductive disks and single housings. At the same time accidental short circuiting is prevented, and accurate occurrence of sparking insured by the use of appropriate insulating material in said housings or encasing members.

Extending through the binding posts 24 and the end clamps 23 is a passageway 35 through which compressed air from a tube 36 is introduced into the device, and the disks 22 and 25 are provided with apertures 37 preferably arranged in staggered relation to permit passage of air between the gaps 33 and through the various cells. The course of air is thus that indicated by the arrows, it being introduced through one binding post and out at the other.

The disks are recessed at points 38 whereby to engage the appropriate connectors 12, 13, and are of such dimension that they engage the other connector 12 at 39 so that said disks are held firmly in place between the connectors. In order to vary the length of the spark the disks are provided with aligned apertures 41 through which a short circuiting rod 42 having an insulating handle 43 and a split end 44 is adapted to extend. A bushing 45 is provided upon one of the plates or disks 22, being adapted to be positioned thereon by means of a slot 46 appropriately formed to fit upon the edge of the disk. It will be apparent that by inserting this rod through a greater or less number of the disks, any desired number of them may be short circuited so that sparking will occur only between the units on the other disks. It will be apparent that with the foregoing construction I have provided a spark gap of comparatively few parts, simply arranged, and efficient in operation.

It is though that the invention and many of its attendant advantages will be understood from the foregoing description, and it will be apparent that various changes may be made in the form, construction and arrangement of the parts without departing from the spirit and scope of the invention or sacrificing all of its material advantages, the form hereinbefore described being merely a preferred embodiment thereof.

I claim:

1. An electric spark gap, comprising a series of cells, each composed of spaced disks of current conducting material provided with projections extending into the cell in opposed relationship and a ring of opaque insulating material eccentrically positioned and extending between said disks and enclosing said projections to insure sparking therebetween, means for clamping the disks and rings of the several cells together to form a unitary apparatus, and current conducting means associated with the disks at the opposite ends of the apparatus.

2. An electric spark gap, comprising a series of cells, each composed of spaced disks of current conducting material provided with projections extending into the cell in opposed relationship and a ground glass ring eccentrically positioned and extending between said disks and enclosing said projections to insure sparking therebetween, means for clamping the disks and rings of the several cells together to form a unitary apparatus, and current conducting means associated with the disks at the opposite ends of the apparatus.

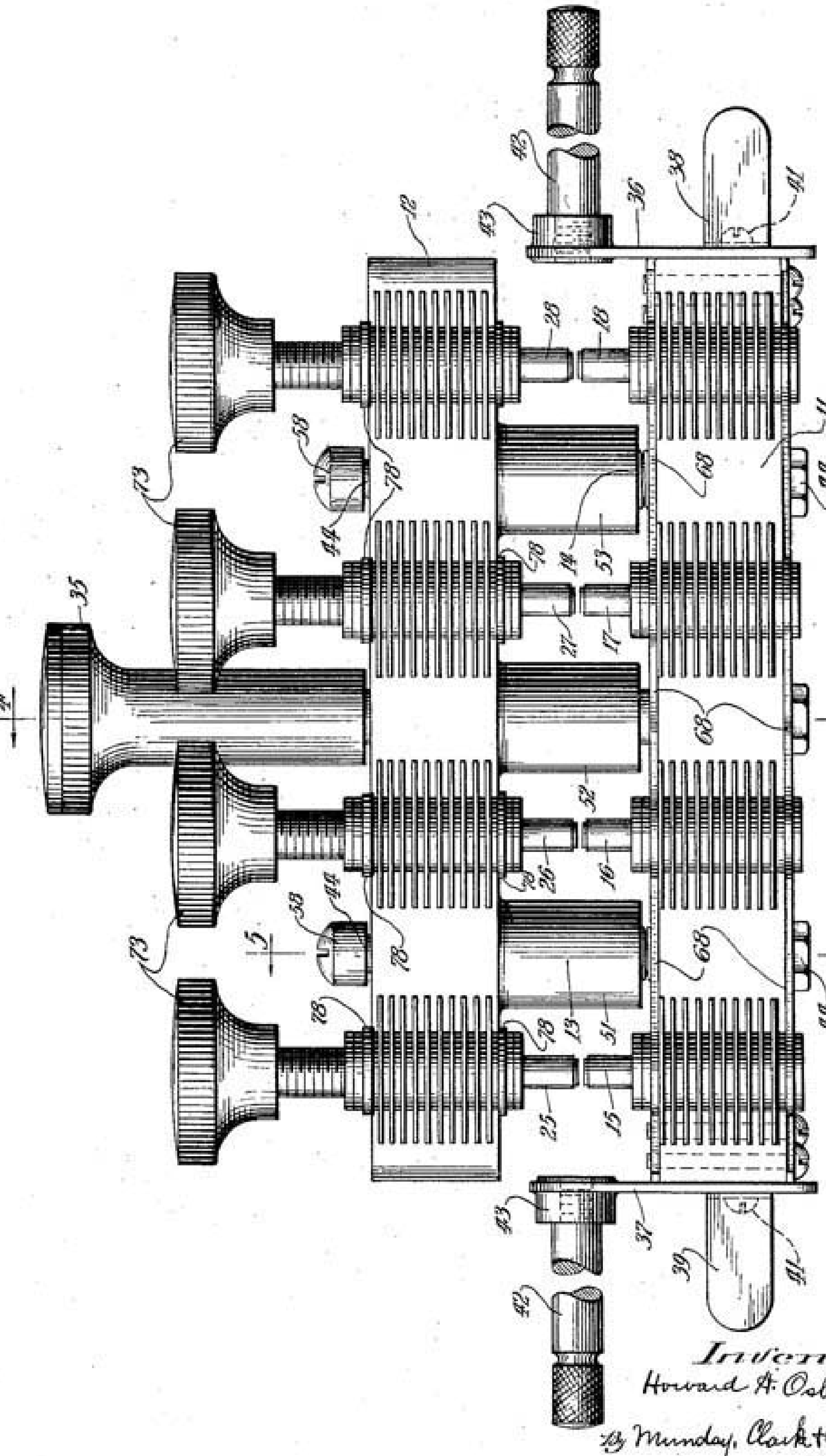
HOWARD H. OSBORN.

June 17, 1930. H. H. OSBORN **1,764,279**

SPARK GAP

Filed May 13, 1925 4 Sheets-Sheet 1

Fig. 1.



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SPARK GAP

Filed May 13, 1925 4 Sheets-Sheet 2

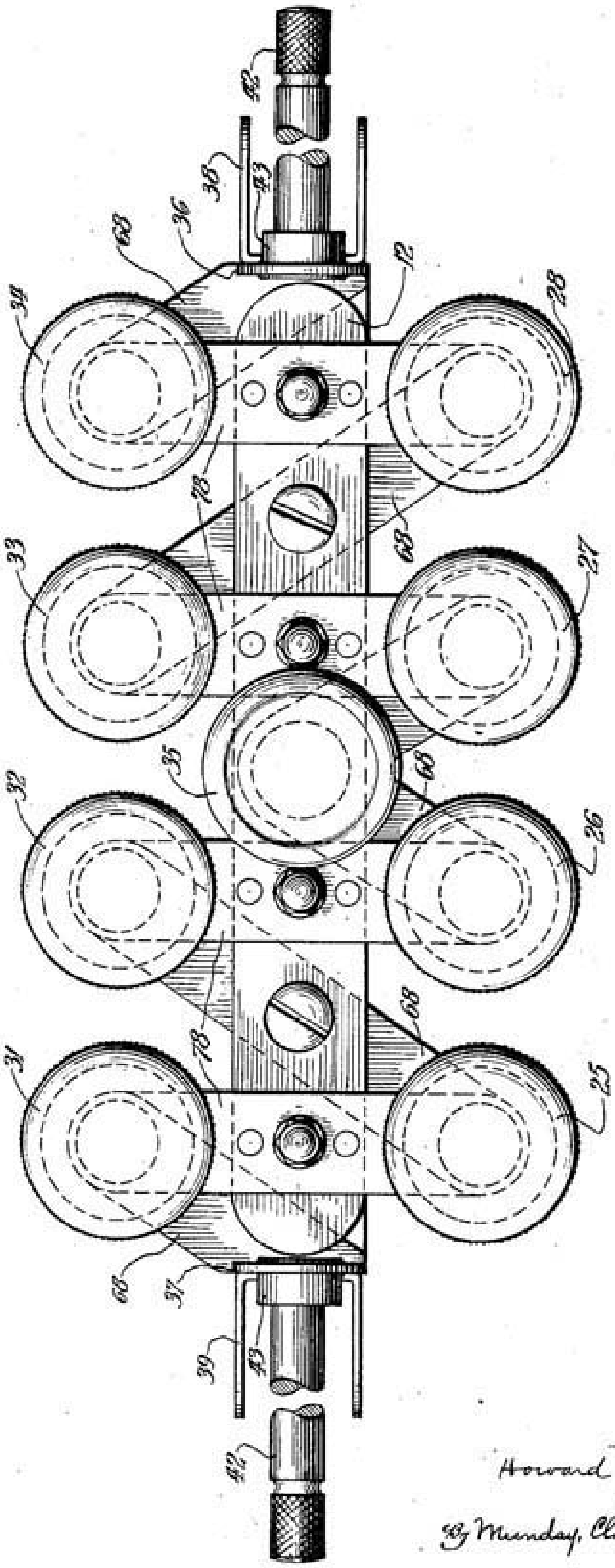

Fig. 2.

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SPARK GAP

Filed May 13, 1925 4 Sheets-Sheet 3

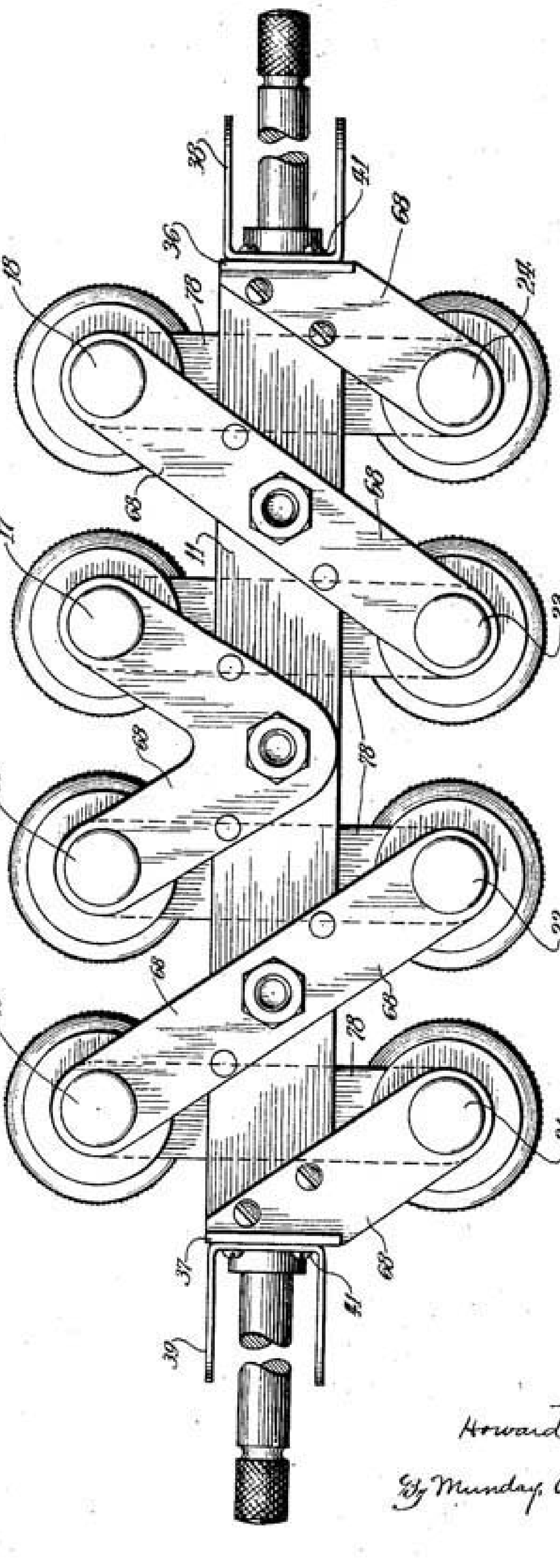

Fig. 3

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SPARK GAP

Filed May 13, 1925 4 Sheets-Sheet 4

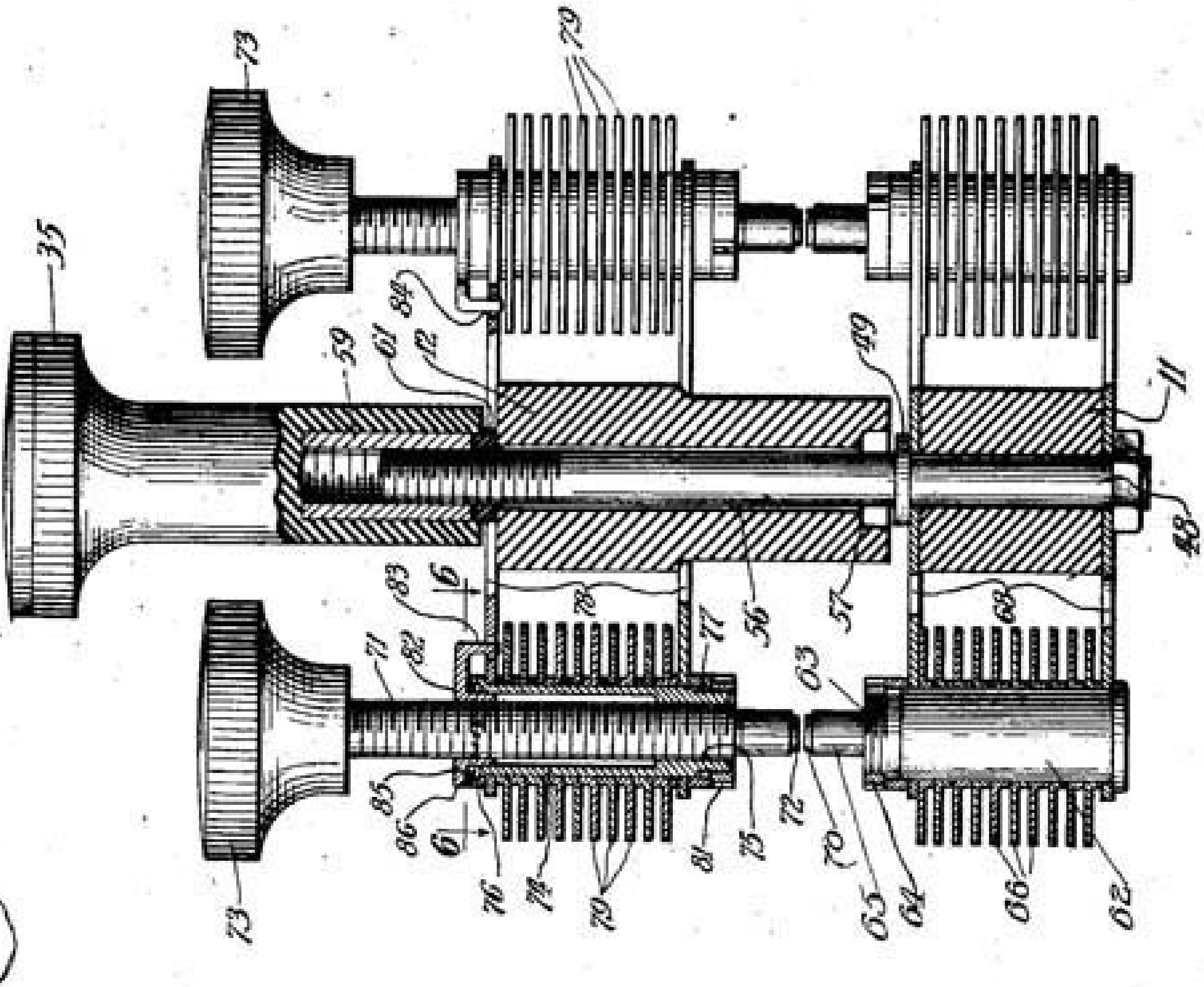

Fig. 4.

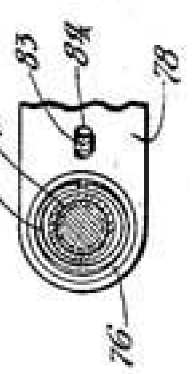

Fig. 6.

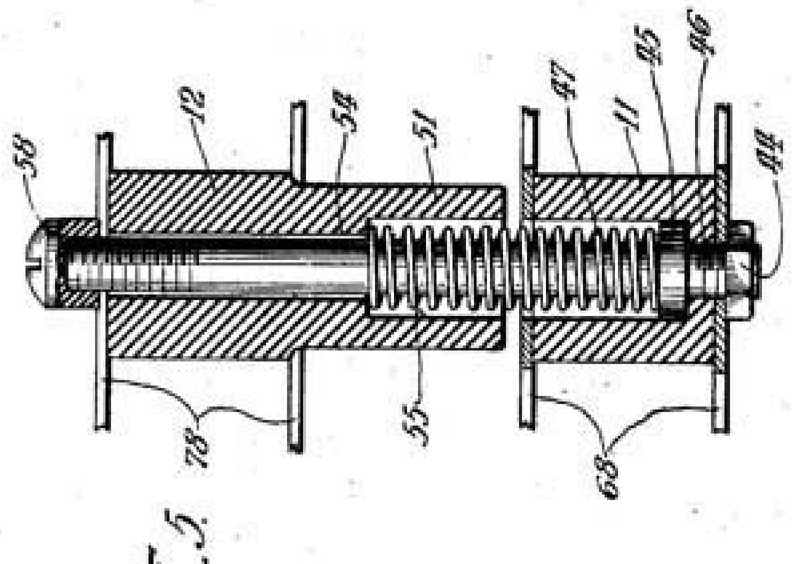

Fig. 5.

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UNITED STATES PATENT OFFICE

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SPARK GAP

Application filed May 13, 1925. Serial No. 29,897.

This invention relates in general to spark gaps, and more particularly to that type of device adapted for use in electrothereapeutic apparatus and the like.

An important object of the invention is the provision of a spark gap which may be adjusted in substantially infinite degrees from zero capacity of the device to maximum capacity of the device in order to facilitate accurate control of the current flow.

Another important object is the provision of a spark gap which insures against sudden change in the current passing the gap as is common in devices provided heretofore which have tap switches or similar means for connecting in or shunting out fixed spark gaps. With such devices, it is undesirable to vary the current during a treatment, because of the resulting severe shock to the patient.

Another important object of the invention is the provision of a compact spark gap device comprising a plurality of individual spark gaps connected in a series circuit, the operative parts of which however are amply spaced to prevent arcing and which are arranged relatively in such a manner that the magnetic fields, generated at the individual spark gaps upon discharge of the device, counter-act and nullify each other and create a balanced resultant magnetic field, thus preventing the production of any appreciable magnetic effect by the device when in operation.

Numerous other objects and advantages of the invention will be apparent as it is better understood from the following description, which, taken in connection with the accompanying drawings, discloses a preferred embodiment thereof.

Referring to the drawings:

Figure 1 is a side elevation of a device embodying my invention;

Fig. 2 is a top plan view thereof;

Fig. 3 is a bottom plan view thereof;

Fig. 4 is a section taken substantially on line 4—4 in Fig. 1;

Fig. 5 is a section taken substantially on line 5—5 in Fig. 1; and

Fig. 6 is a section taken substantially on line 6—6 in Fig. 4.

To illustrate my invention I have shown on the drawings a pair of frame members 11 and 12 comprising bars of suitable non-conducting material yieldably secured together as at 14 by means of posts 51, 52 and 53 formed integrally with the upper frame member 12 and extending to adjacent the lower frame member. A plurality of fixed electrodes 15, 16, 17 and 18 having upwardly disposed tips are supported from the frame member 11 on one side thereof and are arranged in parallelism in spaced relationship along the frame member by means of strips of conducting material 68 comprising supporting members which engage the upper and lower sides of the frame member 11 and extend therefrom and engage the electrodes to support them in position. Similar electrodes 21, 22, 23 and 24 are similarly supported from the frame member 11 on the opposite side thereof and each is preferably disposed directly opposite a corresponding one of the electrodes 15, 16, 17 and 18, to provide a symmetrical arrangement of the electrodes. Adjustable electrodes 25, 26, 27 and 28, having downwardly disposed tips are supported from the upper frame member 12 on one side thereof and are arranged in registering alignment with the lower fixed electrodes 15, 16, 17 and 18, and similar electrodes 31, 32, 33 and 34 are supported on the opposite side of the frame member 12 opposite the electrodes 25, 26, 27 and 28 and in registering alignment with the lower fixed electrodes 21, 22, 23 and 24 by means of supporting strips 78 which engage the upper and lower faces of the frame member and extend therefrom to embrace and support the electrodes in assembled position. An adjustable handle 35 is provided to vary the spacing of the frame members 11 and 12 and thereby control the width of the spark gaps formed between the tips of the adjustable and fixed electrodes. Terminal brackets are preferably provided at opposite ends of the frame member 11 for mounting the device in a high frequency apparatus or the like, and in the present instance, I have shown brackets 36 and 37 and U shaped brackets 38 and 39 secured to the frame member 11 by means of screws 41. These brackets are formed to engage suitable terminal post supports to which the gap may be secured by means of shoulder pins 42 having threading engagement in an enlarged portion 43 of the brackets 36 and 37, and adapted for frictional engagement in suitable apertures in the support, the frictional engagement providing suitable electrical contact for connecting the device in a circuit.

The frame member 11 is or may be of any suitable insulating material of sufficient length, and is preferably square or rectangular in cross section. Shoulder studs 44 having an enlarged portion 45 are secured to the frame member 11 having a bearing at 46. Two or more of these shoulder studs are preferably provided and spaced an equal distance on opposite sides of the center of the frame member 11. Spaces are formed in the frame member 11 above the enlarged portion 45 of the shoulder stud 44 to provide a suitable housing for the lower end of a spring 47. A stud 48 having an enlarged portion 49 engages an aperture through the mid portions of the frame member 11. The frame member 12 is also preferably of insulating material, is equal in length to the frame member 11 and is substantially rectangular in cross section having a plurality of depending bearing lugs 51, 52 and 53 positioned in alignment with studs 44 and 48. The lugs 51 and 53 are apertured as at 54 to receive and provide a free sliding fit for the studs 44 and counterbored as at 55 to provide a housing for the upper end of the spring 47, which normally tends to separate the frame members 11 and 12. The lug 52 is apertured as at 56 to provide a free sliding fit for the stud 48 and may be counter-bored as at 57 to provide clearance for the enlarged portion 49 of the stud 48. Separating movement of the frame members 11 and 12 is limited by threaded caps 58 engaging the threaded end of the studs 44, which protrude above the upper surface of the frame member 12. The adjusting handle 35 is formed of insulating material and has a threaded bushing 59 moulded therein for engaging the threaded end of the stud 48 which protrudes above the upper surface of the frame member 12. A washer 61 is preferably placed between the adjusting handle 35 and frame member 12 to reduce friction. It will thus be noted that rotation of the operating handle 35 in one direction forces the frame member 12 toward the frame member 11 against the compression of the springs 47, and rotation in the opposite direction permits the springs to separate the frame members 11 and 12 and to vary the gap between the several electrodes.

The fixed electrodes 15 to 18 and 21 to 24 inclusive are formed from a suitable conducting material and each comprises a shoulder pin 62 of sufficient length to extend through the supporting strips 68 which are secured to opposite sides of the frame member 11 and which are apertured for the purpose. The pin 62 is threaded at 63 to receive a nut 64 by which pin is secured in position through the apertured supporting strips 68. A portion 65 of the pin 62 extends upwardly to form a contact member having a platinum or other suitable contact point 70 suitably secured thereon. The tips of the fixed electrodes are disposed in a plane intermediate the frame members 11 and 12. A plurality of annular radiating fins 66 are positioned over the pin 62, and between the links 68 for cooling the electrode.

The adjustable electrodes 25 to 28 and 31 to 34 inclusive are formed of suitable conducting material and are supported in any suitable manner providing longitudinal adjustment of each electrode, in order that the fixed and movable electrodes may be spaced adjustably apart to provide spark gaps therebetween. In the present instance, I have shown screw threaded electrodes 71 each provided with a platinum or other suitable contact point secured to a lower end thereof and a control handle 73 secured to the opposite upper end of the electrode. A bearing sleeve 74 having an internal threaded portion 75 adapted to threadingly engage the electrode 71 and having an enlarged shoulder 76 at the upper end and an externally threaded portion 77 at the lower end, is arranged to support each electrode in place. The bearing sleeve 74 has sufficient length to extend through a pair of supporting strips 78 which are secured to the opposite sides of the frame member 12 and which are apertured to accommodate the bearing sleeve 74. A plurality of annular radiating fins 79 which provide a means for spacing the supporting strips 78 apart are assembled externally upon the bearing sleeve between the strips. The shoulder 76 is adapted to engage the upper of the supporting strips 78 and upon assembly is secured in place by means of a nut 81 engaging the threaded portion 77 at the bottom end of the sleeve and engaging the lower of the supporting strips 78. A second threaded nut 82 having internal threaded engagement with the electrode 71 and external sliding engagement with the bearing sleeve 74 and having a depending finger 83 adapted to engage a recess or aperture 84 in the upper of the supporting strips 78 is provided at the top of the spacing sleeve 74, and an annular spring 85, having a normal upward pressure, is arranged in a pocket 86 at the upper end of the spacing sleeve 74 and provides frictional engagement therewith to prevent rotation of the electrode 71 such as may be caused by vibration of the device set up by the discharge of electrical current across the spark gaps.

The supporting strips 68 and 78 for the adjustable electrodes are electrical conductors and provide electrical connection between adjacent electrodes. The spark gaps formed between the spaced ends of co-operating upper and lower electrodes are arranged electrically in series between the bracket electrodes 42 by means of the electrical interconnection of the various electrodes through the connecting strips 78 and 68. The electrodes 21 and 24 are secured by short strips 68 to the supporting brackets and connected electrically to the pins 42. The electrodes 15 and 18 mounted opposite the electrodes 21 and 24 are electrically connected to the electrodes 22 and 23 mounted adjacent the electrodes 21 and 24 by means of the diagonal connecting strips 68, and the adjacent electrodes 16 and 17 are electrically connected and supported in position by a V-shaped connector. The upper and lower electrodes are each connected electrically to a diametrically opposed electrode, electrode 25 being connected to 31, 15 to 22, 32 to 26, 16 to 17, 27 to 33, 18 to 23 and 28 to 34 by means of the transverse connecting strips 78. All the spark gaps formed between cooperating electrodes are thus arranged in series and the spark gap circuit extends from a terminal support 42 through the short support strip 68 to the lower electrode 21 and up through a spark gap to the co-operating upper electrode 31, thence across the device through one of the cross connectors 78 to the diametrically disposed electrode 25 and down through a gap to the cooperating lower electrode 15, thence diagonally through one of the long strips 68 to the lower electrode 22 and up through a spark gap to the cooperating upper electrode 32 thence across the device through another of the cross connectors 78 to the diametrically disposed upper electrode 26 and down through a spark gap to the co-operating lower electrode 16. This somewhat spiral path of the circuit through the device now reverses. The lower electrode 16 is connected to the adjacent lower electrode 17 on the same side of the device by means of the V-shaped connector 68 instead of to the diagonally disposed electrode 23. The circuit from the lower electrode 17 continues up through a spark gap to the cooperating upper electrode 27, thence across to the diametrically disposed electrode 33 and down through spark gap to the cooperating lower electrode 23, thence diagonally across to the lower electrode 18 and up through a spark gap to the cooperating upper electrode 28, thence across the device to the diametrically disposed upper electrode 34 and down through a spark gap to the cooperating lower electrode 24 which is connected to the other terminal support 42, thus completing the circuit between the terminal supports.

From this description it will be noted that the spark gaps lie in a plane and are symmetrically grouped. When a discharge occurs, current will flow through the spark gap circuit between the terminal posts 42, the current travels upwardly across the spark gaps formed between terminals 21 to 31, 22 to 32, 17 to 27 and 18 to 28, while travelling downwardly between terminals 25 to 15, 26 to 16, 33 to 23, and 34 to 24, and vice versa. It will also be noted that the gaps besides being arranged symmetrically are connected electrically so that the magnetic fields produced by the gaps upon discharge are balanced about any axis lying in the plane of the gaps and about which the gaps are symmetrically disposed. This arrangement provides a non-magnetic spark gap device, in which the fields produced by the individual spark gaps counteract and nullify each other and substantially eliminate the possibility of magnetic disturbance produced by the resultant of the individual fields. The nullification of the magnetic effect is produced by grouping the spark gaps symmetrically and by connecting the parts electrically in such a manner that the instantaneous current flow across the individual gaps produces a plurality of symmetrically disposed magnetic fields, the magnetic sum of which is substantially zero.

It will be noted that a slight movement of the operating handle 35 produces a considerable variation in the total effective gap of the device, which comprises the sum of the lengths of the individual gaps and that adjustment of any of the knobs 73 which control individual gap setting provides an extremely fine vernier adjustment. All of the operating handles are threaded so that the change in the spark gap setting and hence in the amount of current passing through the gap may only be effected gradually. This feature prevents sudden variations in the current which, as before noted, shock the patient. Adjustment to accommodate for wear or deterioration of the contact points of the electrodes are also possible because of the adjustability of the electrodes.

The utility of a non-magnetic spark gap is most apparent when a spark gap is required in apparatus including delicate measuring instruments. The operation of such instruments may be seriously effected by external magnetic disturbances with the result that when ordinary spark gaps are used, it is necessary to mount the gap in a separate container positioned at a distance from the delicate instruments, or to shield the gap in a specially constructed compartment providing a magnetic shield. Such assembly is cumbersome, costly, and provides an inconveniently bulky apparatus. The non-magnetic spark gap obviates the necessity of shielding delicate instruments from the magnetic disturbances and allows the provision of compact apparatus at a correspondingly low cost of production.

It is thought that the invention and many of its attendant advantages will be understood from the foregoing description, and it will be apparent that various changes may be made in the form, construction and arrangement of the parts without departing from the spirit and scope of the invention or sacrificing all of its material advantages, the form hereinbefore described being merely a preferred embodiment thereof.

I claim:

1. A spark gap device comprising a frame member, a plurality of fixed electrodes supported symmetrically from said frame member, a second frame member and a plurality of movable electrodes supported on said second frame member arranged to cooperate with said fixed electrodes and having axial alignment with said fixed electrodes, spark gaps being formed between the cooperating fixed and movable electrodes, means securing said frame members in spaced relationship, and means for varying said relationship to provide gap adjustment between cooperating electrodes.

2. A spark gap device, comprising, a frame member, a plurality of electrodes secured to said frame member, a second frame member, a plurality of electrodes adjustably secured to said second frame member and arranged to cooperate with said fixed electrodes to form spark gaps therebetween, cooperating electrodes being arranged in alignment, connecting means for connecting said first mentioned frame member and said second frame member, and means varying the space between said frame members to simultaneously vary the gaps between said fixed and said adjustable electrodes.

3. A spark gap device, comprising, a frame member, a plurality of electrodes secured to said frame member, a second frame member, a plurality of electrodes adjustably secured to said second frame member and arranged in registering alignment with said fixed electrodes and to provide spark gaps, connecting means for connecting said first mentioned frame member and said second frame member, and means varying the space between said frame members to simultaneously vary the gaps between said fixed and said adjustable electrodes, said fixed and adjustable electrodes being connected in series.

4. A spark gap device comprising a frame member, a plurality of fixed electrodes secured to said frame member, a second frame member, a plurality of adjustable electrodes secured to said second frame member and arranged in registering alignment with said fixed electrodes and to provide spark gaps, connecting means for connecting said first mentioned frame member and said second frame member, and means varying the space between said frame members to simultaneously vary the gaps between said fixed and said adjustable electrodes, said adjustable electrodes having threaded engagement in said second frame member to provide adjustment for individual spark gaps.

5. A spark gap device, comprising a plurality of pairs of spark gap electrodes, each pair comprising a fixed and a movable electrode, means for adjusting the movable electrode of each pair toward and into contact with its companion fixed electrode, and means for simultaneously moving all of said movable electrodes toward and from their companion fixed electrodes.

6. A spark gap device, comprising a pair of frame members arranged for relative adjustment toward and from each other, a set of fixed electrodes carried in one of said frame members, and a set of movable electrodes carried in the other frame member and in axial registration with said fixed electrodes, and carriers for said movable electrodes adjustably mounted in said frame member for individual adjustment of said movable electrodes.

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Oct. 13, 1931. W. B. CHAPMAN ET AL 1,827,306

ELECTRODE

Filed Sept. 14, 1925

Fig. 2.

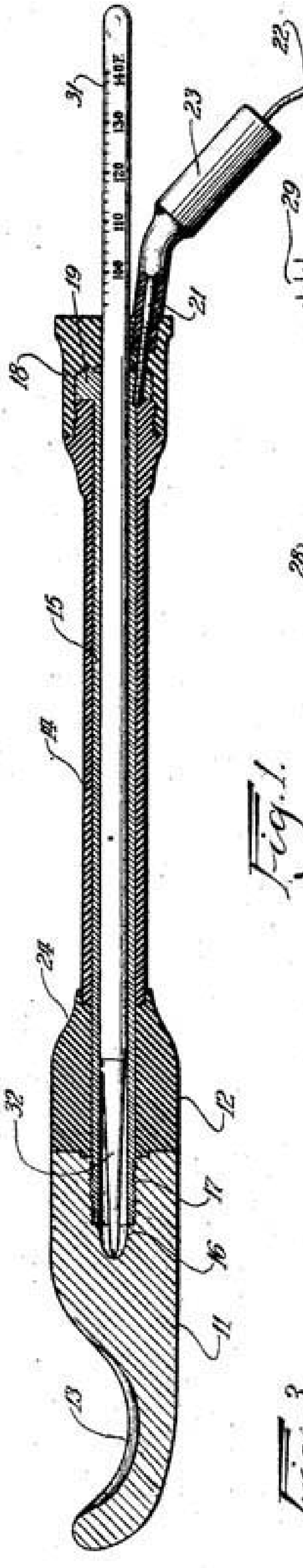


Fig. 1.

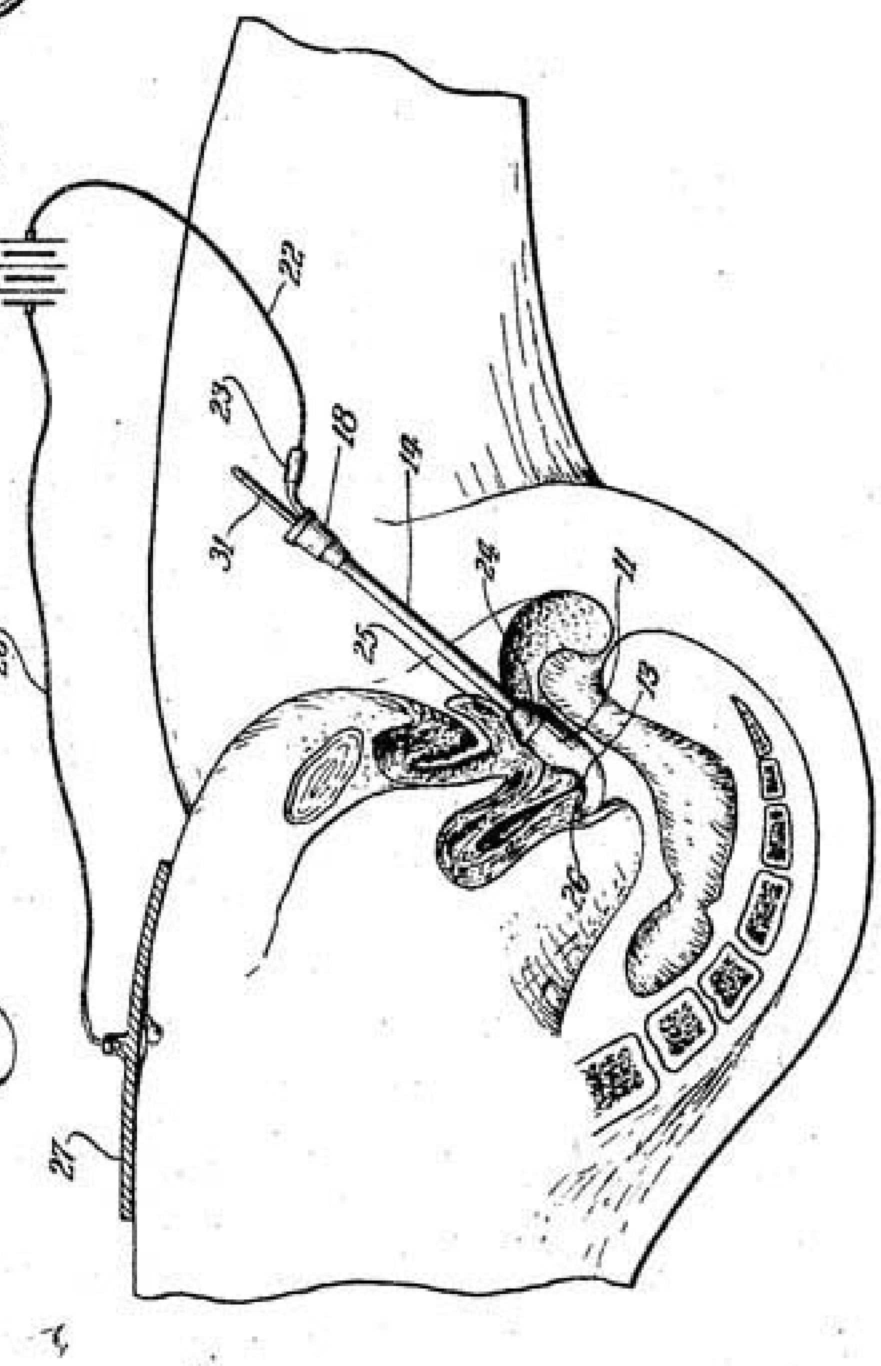
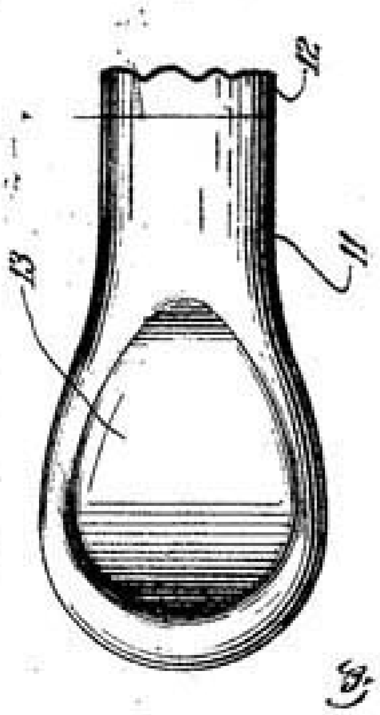


Fig. 3.



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Patented Oct. 13, 1931 **1,827,306**

UNITED STATES PATENT OFFICE

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ELECTRODE

Application filed September 14, 1925. Serial No. 56,255.

Our invention relates to electrotherapeutic instruments and has for its object the provision of an improved vaginal electrode having, among others, the advantages below alluded to.

An important advantage of the instrument of our invention is that it is made to conform to the contour of the vagina and thus not only renders possible more efficient treatment of the parts affected but is adapted to be held properly in place during the treatments.

The invention also provides a construction adapted to further aid in holding the instrument in place by means of an angular part or "vulval groove" over which the hymenal portion of the vagina closes after insertion of the instrument and prevents the same from falling out.

A further object of the invention is the provision of a vaginal electrode formed to provide a cervical bowl adapted to fit snugly over the cervix uteri, and, if desired, to elevate the same, thus obtaining certain desirable results in treatments not obtainable with any other type of electrode.

Another and highly important feature of the invention is the provision in an electrode of this character of a stem formed to receive a thermometer in a manner to provide temperature readings at all times during the course of the treatment, advising the physician of the temperature conditions of the inserted part of the electrode and, thereby of the results being obtained.

Numerous other objects and advantages of the invention will be apparent as it is better understood from the following description, which, taken in connection with the accompanying drawings, discloses a preferred embodiment thereof.

Referring to the drawings:

Fig. 1 is a view of the instrument placed in the vagina and showing its relation to the pelvic viscera;

Fig. 2 is a longitudinal sectional view showthe relation of the thermometer to the electrode; and

Fig. 3 is a plan view of the cervical bowl of the instrument.

On said drawings we have shown for illustrative purposes only, a preferred form of the invention in which the reference character 11 indicates a non-insulated portion of a tip having an insulating part 12 joined thereto, said non-insulated portion being formed with a bowl 13 for a purpose which will presently appear and said insulating part having an insulating stem 14 extending rearwardly therefrom. Said stem and the part 12 are hollow and adapted to receive a metal tube 15 which is threaded into a socket 16 in the noninsulated portion 11 of the tip as indicated at 17 in Fig. 2. A rubber cap 18 is threaded onto the rear end of the stem 14 and receives an enlargement 19 formed on the rear end of the tube 15, this construction binding the parts together in evident manner to form a unitary device. The electrode is connected with the electric circuit by means of a contact rod 21 threaded into the enlargement 19 of the tube 15 and connected with a wire 22 which may form a part of a D'Arsonval connection. Said rod being insulated by an angularly extending insulating member 23.

The instrument is made to accurately conform to the shape of the female organs and may be introduced through the anterior opening or hymenal portion of the vagina. This is the narrowest portion of the vagina and the surrounding vulval muscles 25 offer some resistance to the introduction of the instrument. After the instrument is properly positioned, the vulval muscles contract and embrace a groove 24 formed in the insulating portion 12 of the tip to retain the electrode in position. After insertion the bowl 13 of the instrument is pushed to the extreme posterior form of the vagina and engages the cervix uteri 26, as shown in Fig. 1. The cervical bowl 13 is shaped to fit over the cervix and to be retained in position by the suction thereof. This is an important feature of the invention for all other vaginal electrodes work out of position during operation, and have to be held in place by externally applied means. An indifferent electrode 27 is applied to the abdomen and is connected electrically to a battery 29 through suitable means for circuit control.

The insulation 12 and 14 extends well within the vagina to protect the external tissues thereof from the heat of the conductor 15, making the effective internal tip temperature much higher than is possible with other types of electrode which do not insulate the external tissues from the heat of the electrode, and which consequently have to be operated at temperatures low enough to accommodate the tolerance of the external tissues. The vaginal mucosa will tolerate temperatures greatly in excess of the external skin.

The curved stem 23 when attached to the electrode stem produces a downward pull thereon that automatically elevates the uterus and brings a sagging, sub-involuted organ into its proper position, thus facilitating treatment thereof by bringing the organ closer to the indifferent electrode 27 and promoting a greater concentration of current thereon.

A thermometer 31 may be inserted through the cap 18 into the interior of the tube 15 to dispose the tip 32 thereof in the socket 16 of the electrode tip 11, so that the temperature thereof is at all times determinable. This is an important feature inasmuch as it is possible to much more accurately control the effects of the treatment and to avoid overheating and resultant burns. No thermometer has been provided in any other electrodes, and it has been necessary for the physician to treat patients according to an estimated tolerance, and concentration of heat necessary to destroy the organisms of infection. With the apparatus of applicants' invention, it is possible at all times to determine whether or not the parts are heating properly and if not, to check the technic to determine wherein the fault lies.

It is thought that the invention and many of its attendant advantages will be understood from the foregoing description, and it will be apparent that various changes may be made in the form, construction and arrangement of the parts without departing from the spirit and scope of the invention or sacrificing all its material advantages, the form hereinbefore described being merely a preferred embodiment thereof.

We claim:

1. An electrotherapeutic device comprising an electrode including a tip insertable in a body cavity, means for connecting said tip in an electric circuit, and a stem secured to said tip and adapted to be disposed outside said body cavity when the device is in use, said stem comprising a hollow tube of conducting material, means for connecting the same into the circuit, the inner end of said tube being engaged with said tip, and an insulating member in which said tube is enclosed, said tube being adapted to receive a thermometer for indicating at a visible point the temperature of the inserted tip.

2. An electrotherapeutic device, comprising an electrode including a non-insulated tip formed with a bowl to engage the cervix uteri when inserted in the vagina, an insulated stem having a shoulder thereon with which the vulval muscles engage by contraction thereabout to hold the device in place in the vagina, and means for connecting the electrode in an electric circuit.

WARREN B. CHAPMAN.
HERMAN G. FISCHER.

Dec. 17, 1935. **H. G. FISCHER ET AL** **2,024,350**

SPARK GAP FOR X-RAY APPARATUS

Filed Dec. 7, 1933

Fig. 1

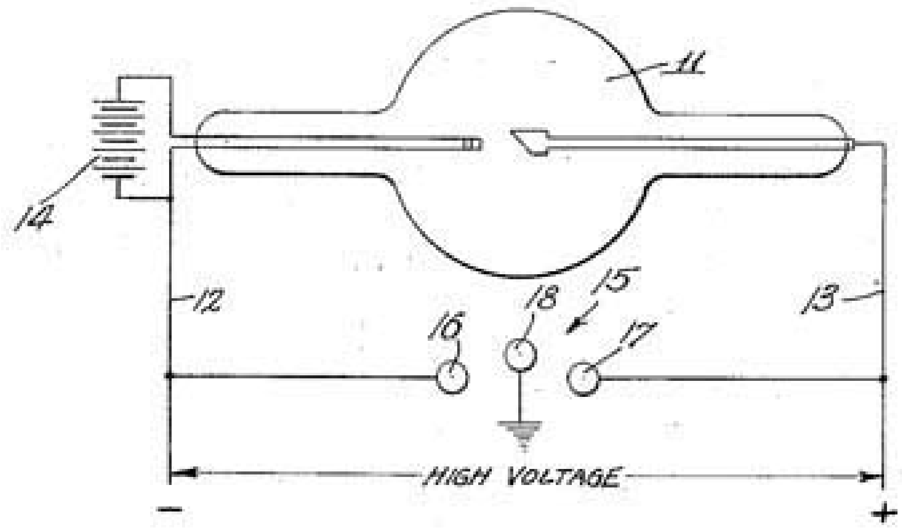


Fig. 2

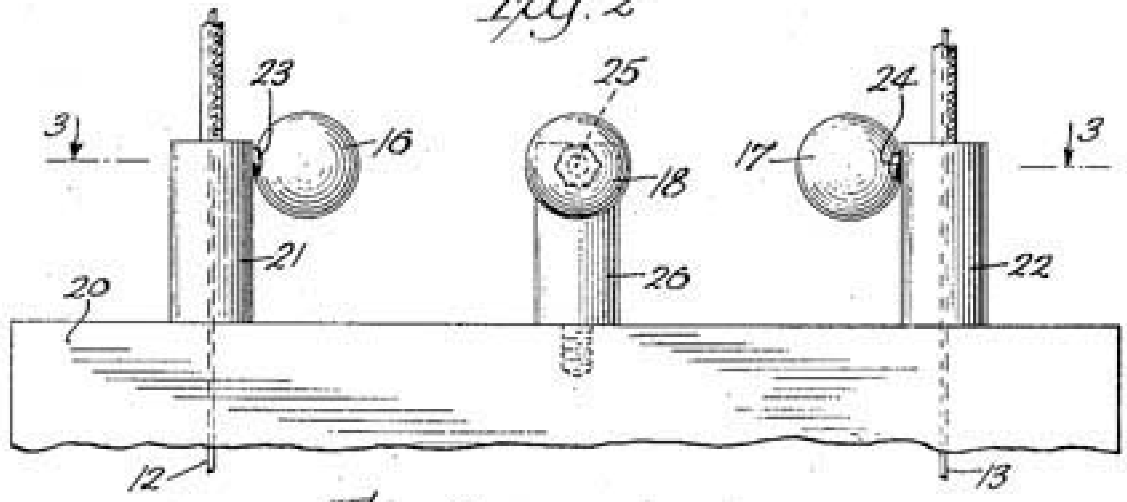
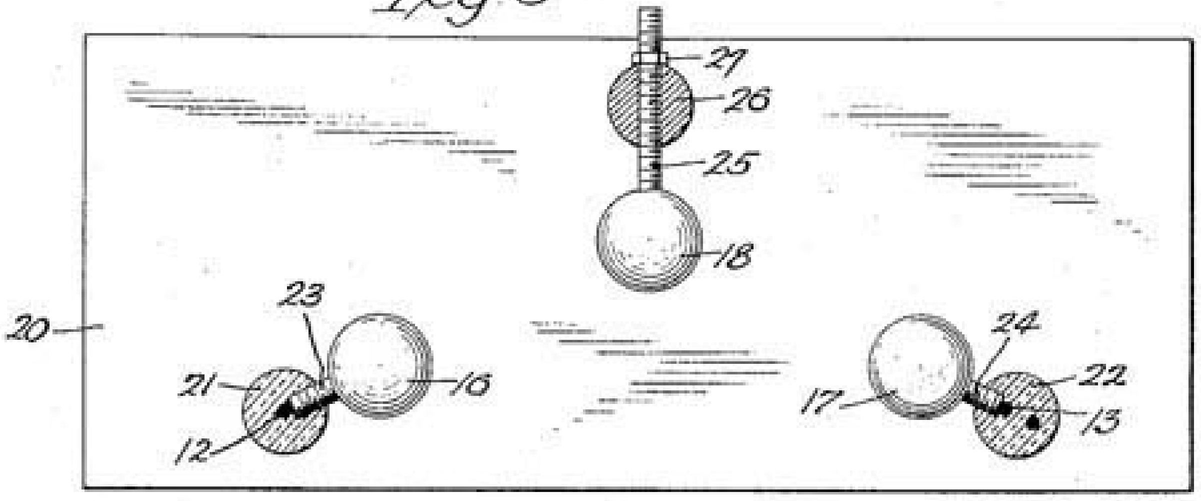


Fig. 3



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Patented Dec. 17, 1935 **2,024,350**

UNITED STATES PATENT OFFICE

2,024,350

SPARK GAP FOR X-RAY APPARATUS

Herman G. Fischer, Peter P. Musket, and Howard H. Osborn, Chicago, Ill., assignors to H. G. Fischer Co. Inc., Chicago, Ill., a corporation of Illinois

Application December 7, 1933, Serial No. 701,302

1 Claim. (Cl. 250—34)

This invention relates to X-ray machines and has more particular reference to improvements in spark gap mountings for such apparatus.

A principal object of the present invention is the provision of spark gaps which will prevent shock to the flexible insulated cables, or excessive strain thereon.

Another object of the invention is to safeguard the leads against sudden, excessive voltage surges which occur in high voltage operations.

A further object of the invention is the provision of a spark gap across the high voltage leads of X-ray apparatus, wherein the spacing of the several electrodes is adjustable.

Another important object of the invention is the provision of spherical spark gap electrodes located at the corners of a triangle with two of these electrodes at the ends of the base of the triangle while the grounded intermediate electrode is located in the apex of the triangle an equal distance from the other two electrodes.

Numerous other objects and advantages of the invention will be apparent from the following description, which, when taken in connection with the accompanying drawing, discloses a preferred embodiment thereof.

On the drawing,

Figure 1 shows, diagrammatically, the relation of the spark gap to an X-ray tube;

Fig. 2 is a side elevation of the electrodes of the spark gap and their mountings; and

Fig. 3 is a top view of the spark gap.

Referring to the drawing, reference character **11** indicates an X-ray tube. Two electrodes connect this tube with high potential flexible insulated leads **12** and **13**. The X-ray tube is wired in the usual way, using the high tension leads **12** and **13** connected to the cathode and anode, respectively, and a subsidiary source of electric energy **14** for heating the cathode.

A spark gap system, indicated at **15**, is shunted across the high voltage leads **12** and **13**. This spark gap system comprises two electrodes **16** and **17** which are conductively connected with the high voltage leads **12** and **13**, respectively, and a third electrode **18** which is grounded. Upon surges of electric energy arising in the high voltage circuit, discharge will occur between either one of the electrodes **16** and **17** and the grounded electrode of the spark gap, thus avoiding injury to the high tension leads.

In the embodiment of the invention illustrated in the drawing, the spark gap is supported by a base or plate **20** carrying two posts **21**, **22** which are or may be made of insulating material, such as synthetic resin, phenol condensate, or the like, and are suitably held in position on the base **20**. These posts are provided with axial bores to receive the high potential leads **12** and **13** extending therethrough. The electrodes **16** and **17**, which constitute the outer electrodes or high potential electrodes of the spark gap, have the form of metal spheres, each sphere being secured to a short threaded stud **23** and **24**, respectively.

The cylindrical posts **21** and **22** are each provided adjacent the top with a radial tapped hole, adapted to receive the threaded stud of the respective sphere, so that upon proper insertion of the threaded stud into the respective tapped bore, the stud will be moved into conductive contact with the respective lead **12** and **13** to connect the respective sphere conductively with the said lead.

The tapped bores in the two posts **21** and **22** are positioned an equal distance from the surface of the base **20** and are arranged within said posts in such manner that the radial lines extending from the centers of the electrodes **16**, **17** axially through the studs **23**, **24** form, on each of the mountings, an equal angle with a line connecting the axes of the posts **21**, **22**.

The central electrode of the spark gap is located at a greater distance from this connecting line, preferably in such manner that extensions of the radial lines through the spheres **16** and **17** will intersect each other in the center of the third electrode **18** which is grounded. The three electrodes, therefore, may be described as being mounted in triangular relation with the two outer electrodes located at the ends of the base of an isosceles triangle at the apex of which the central electrode is mounted.

This third or grounded electrode **18** also is provided with a threaded stud **25** which extends diametrically through a tapped passage in the post **26** of the spark gap mounting, whereby said electrode **18** may be spaced different distances from the said connecting line, or base of the triangle. A nut **27** is adapted to maintain the stud **25** and third electrode **18** in adjusted position relative to its post **26** and to the other electrodes of the spark gap.

The electrodes **16**, **17**, **18** of the spark gap are directed toward each other solely with their spherical surfaces and are so spaced that the discharge of the spark from one outer electrode to the other outer electrode, while skipping the central or grounded electrode, cannot occur.

It is thought that the invention and many of its attendant advantages will be understood from the foregoing description, and it will be apparent that various changes may be made in the form, construction and arrangement of the parts without departing from the spirit and scope of the invention or sacrificing all of its material advantages, the form hereinbefore described being merely a preferred embodiment thereof.

We claim:

A spark gap arrangement for X-ray tubes, comprising a base, posts carrying the leads for the X-ray tube mounted on said base, electrodes fixedly secured to said posts, studs interposed between the surface of the electrodes directed towards said posts and the leads within said posts, a third post rising from the base, and a grounded electrode secured to said third post out of alinement with said first mentioned electrodes and spaced equally therefrom, said grounded electrode being adjustable on a line extending at right angles to a line intersecting said first mentioned electrodes.

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HIGH FREQUENCY APPARATUS

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Fig. 2

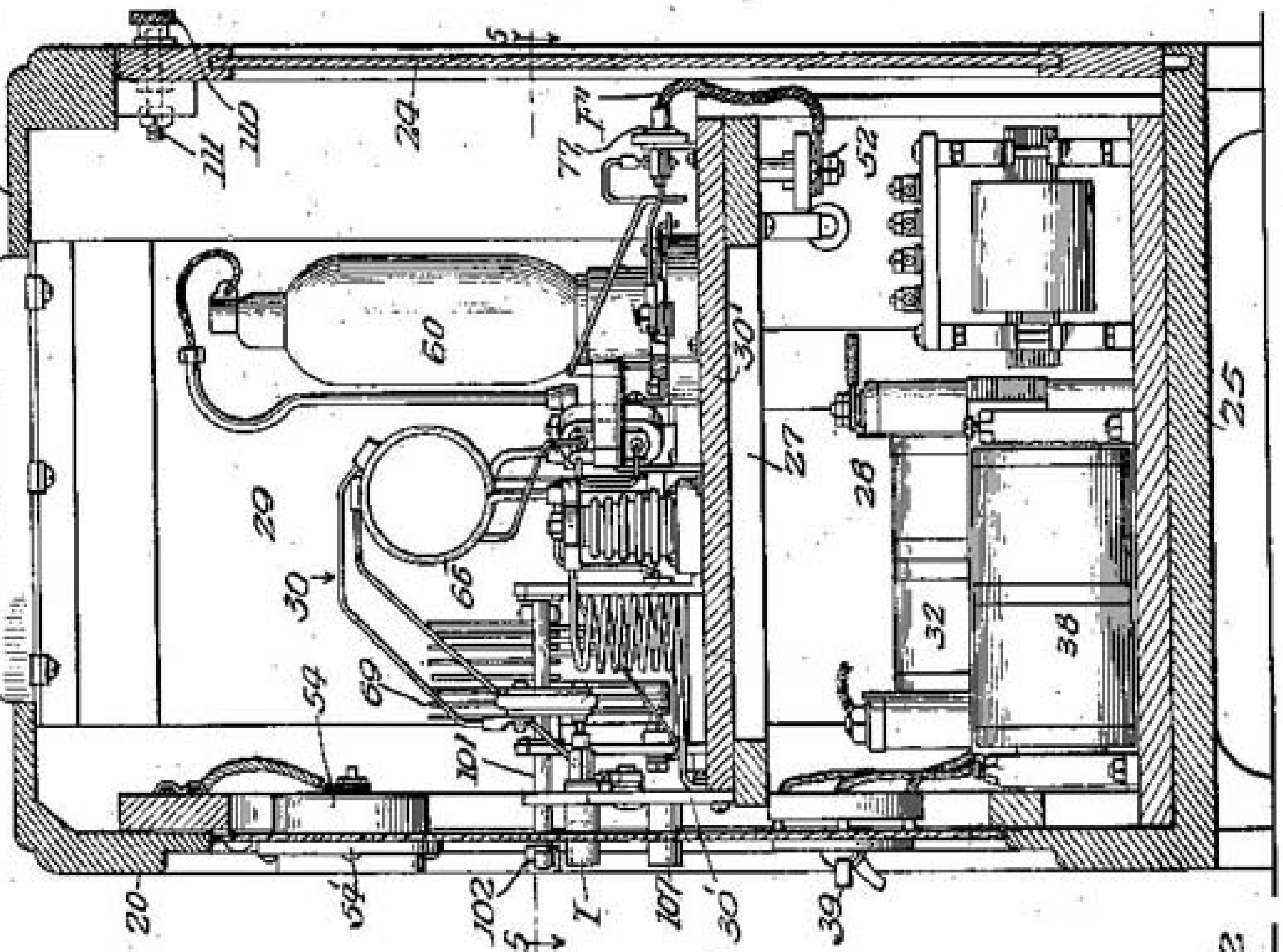
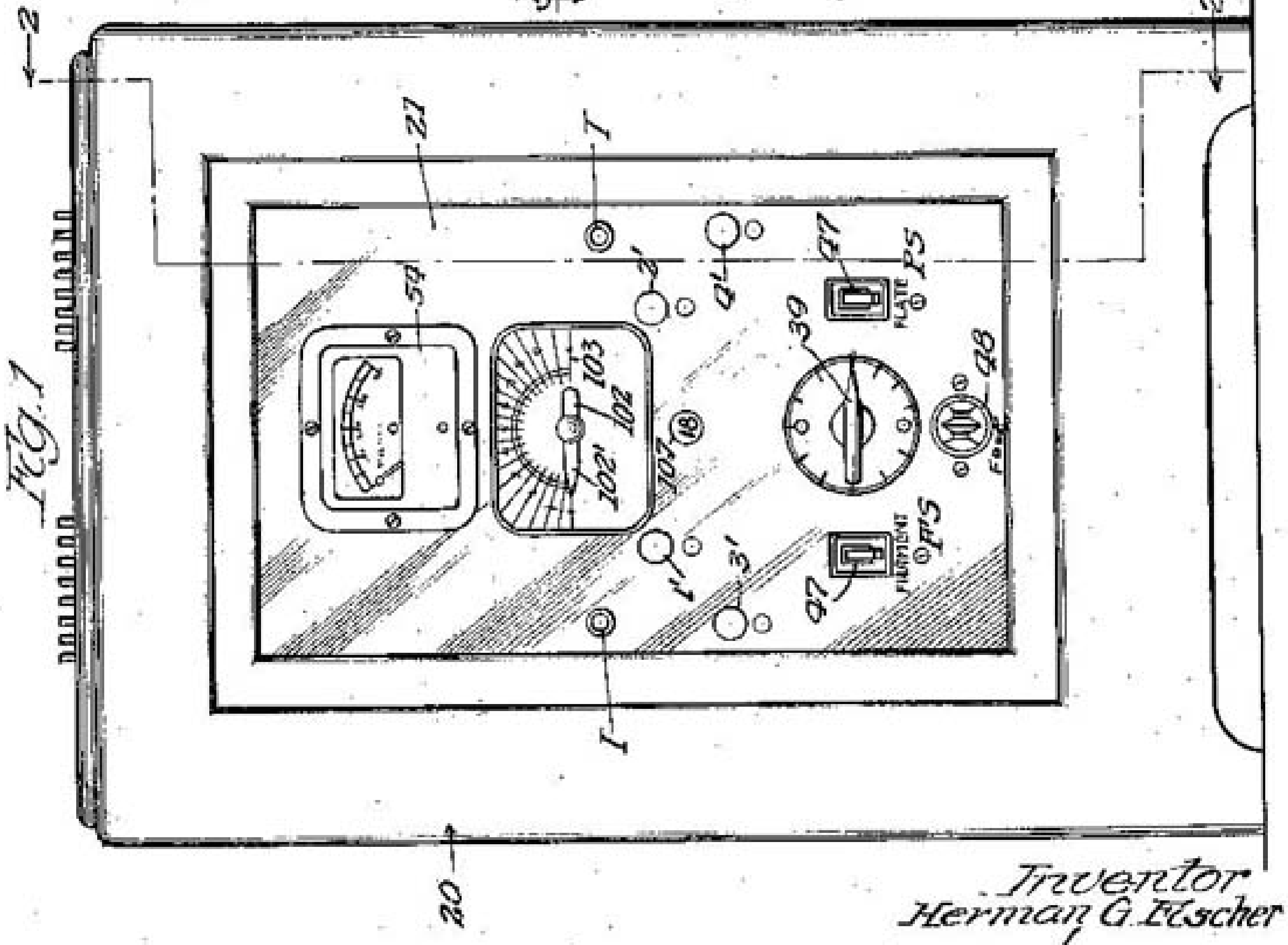


Fig. 1



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HIGH FREQUENCY APPARATUS

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Fig. 2

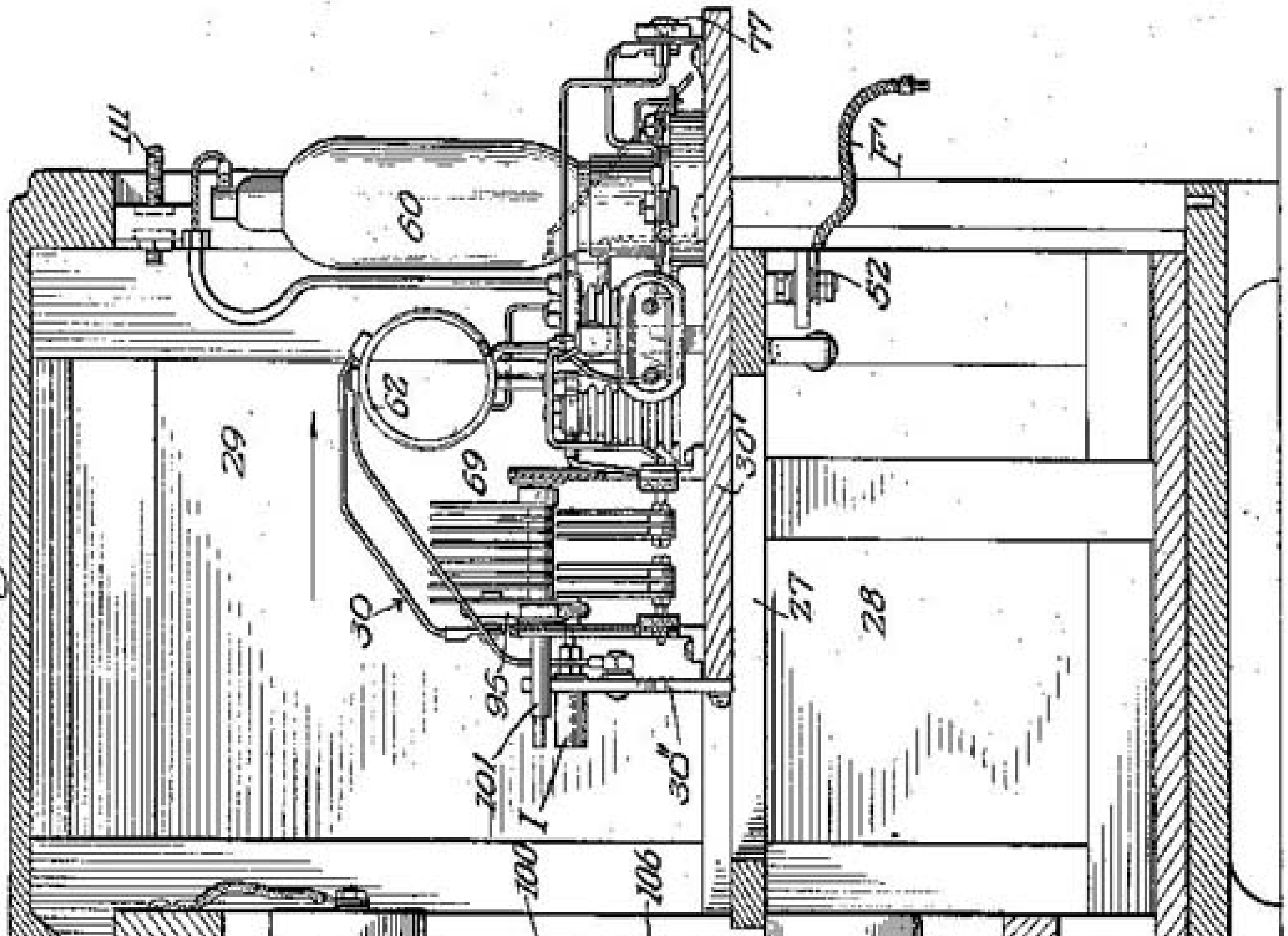
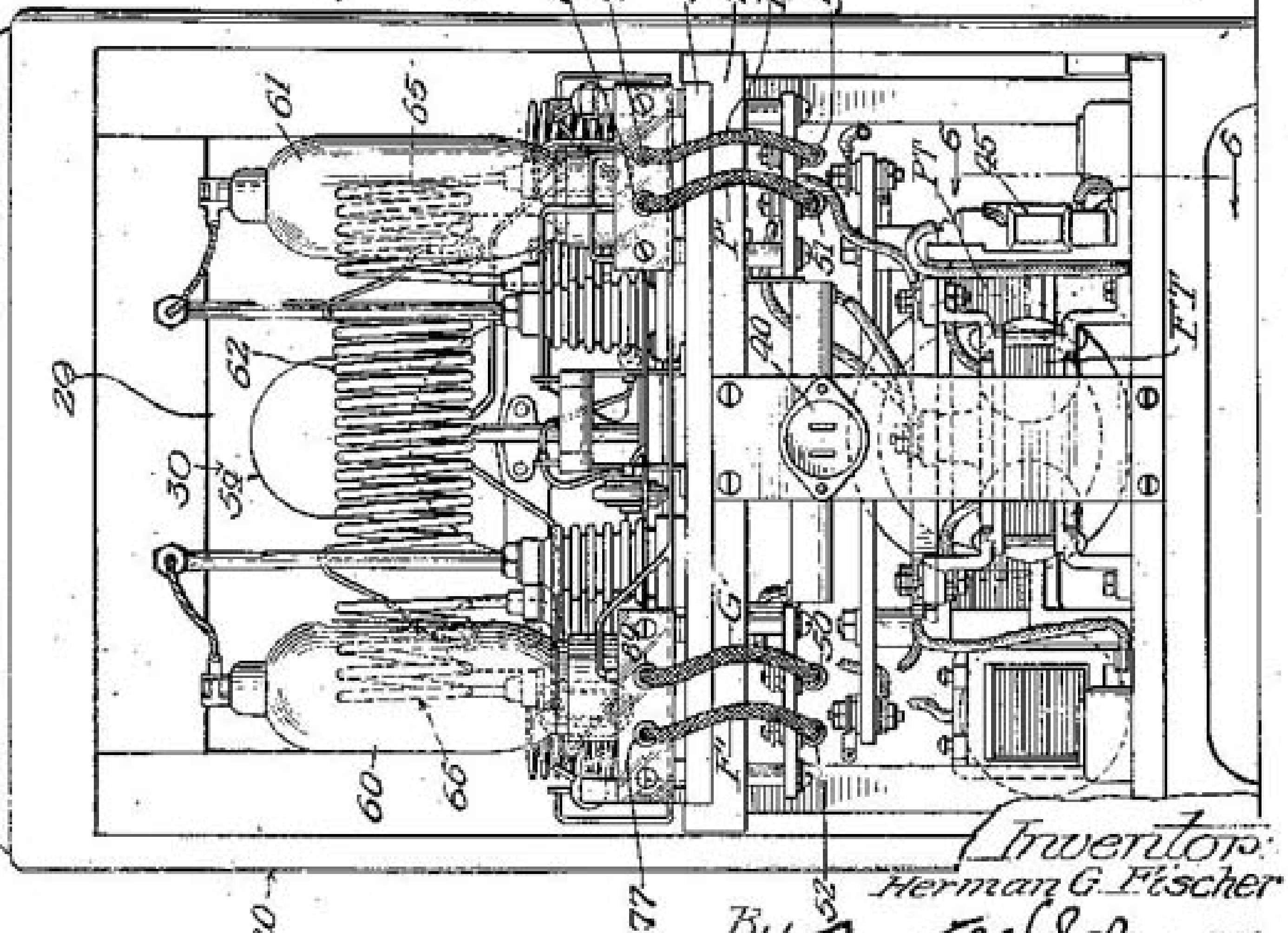


Fig. 3



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HIGH FREQUENCY APPARATUS

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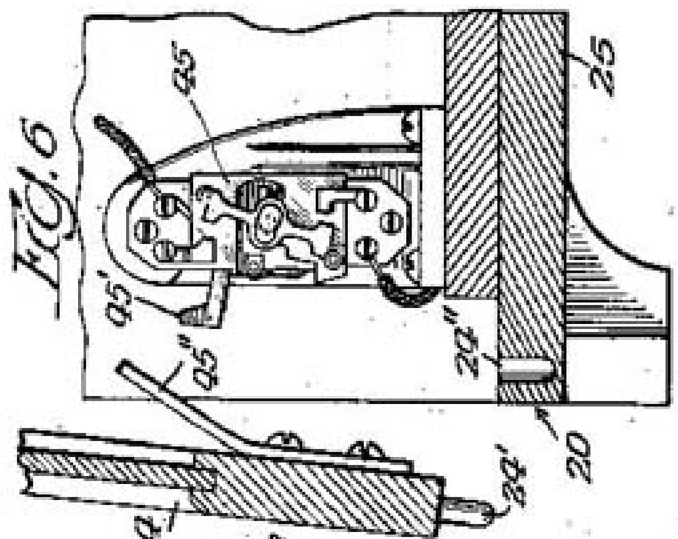
Fig. 6

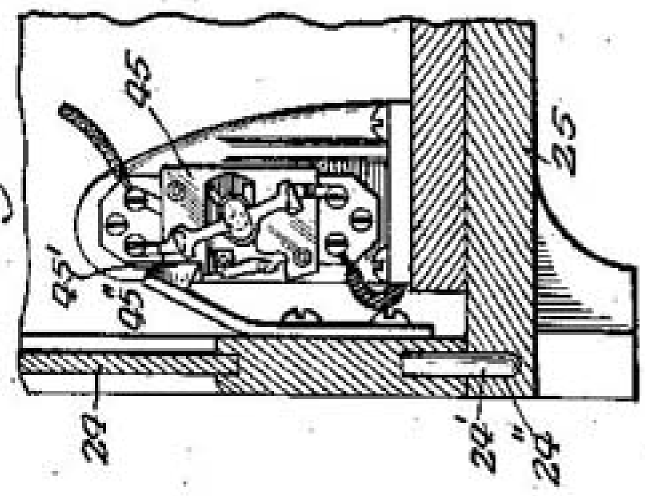
Fig. 7

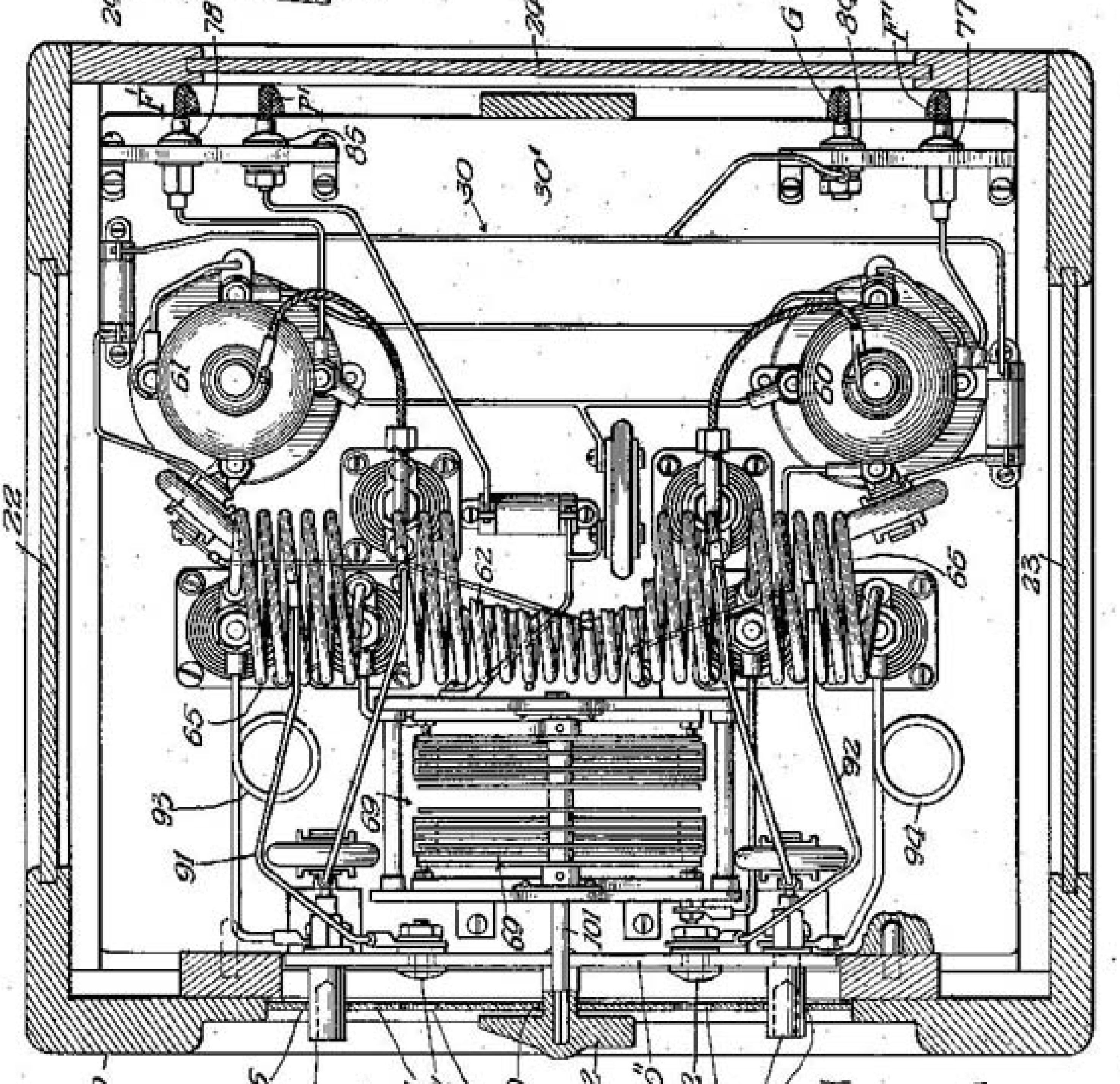
Fig. 5

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HIGH FREQUENCY APPARATUS

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Fig. 8

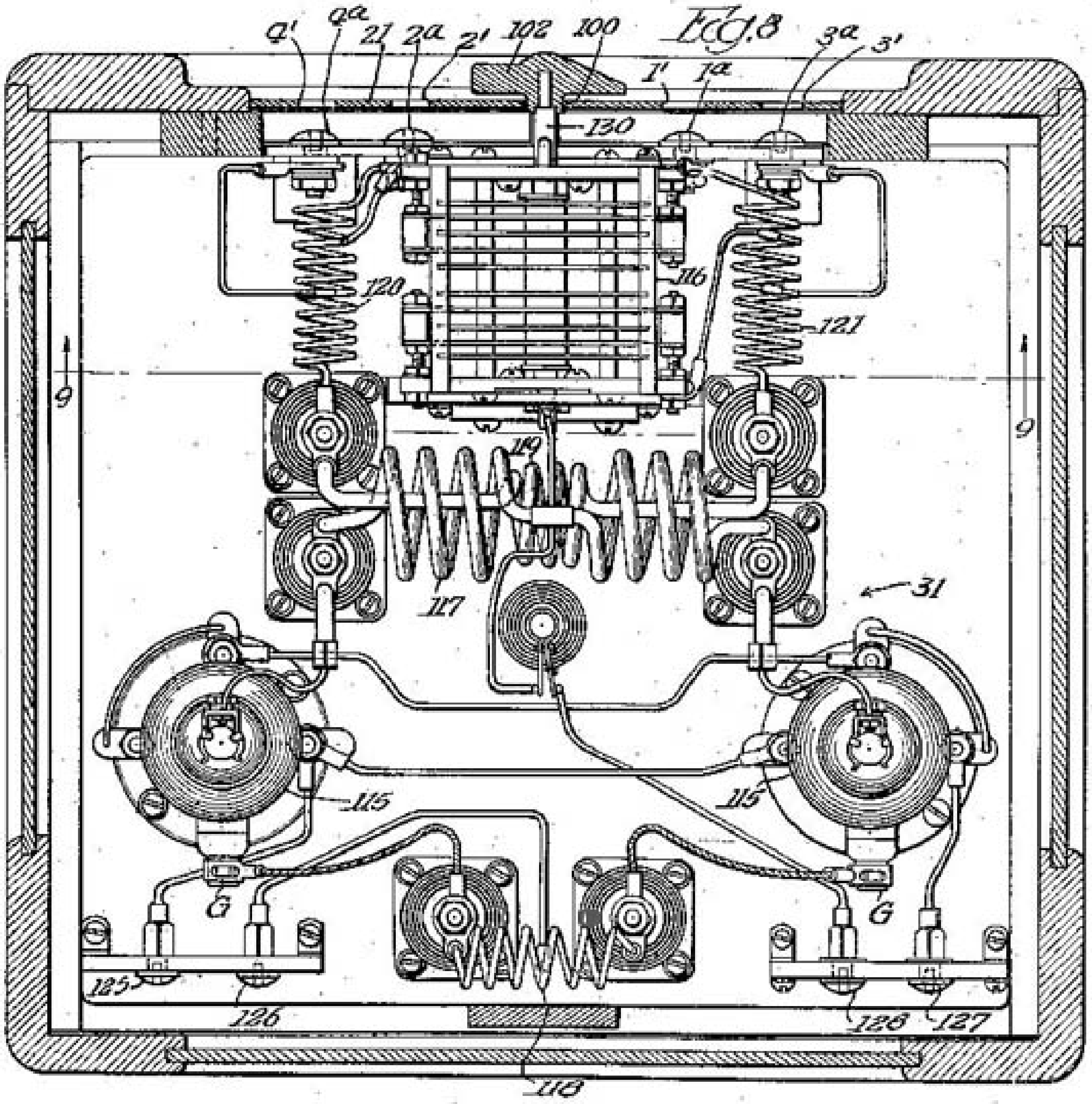
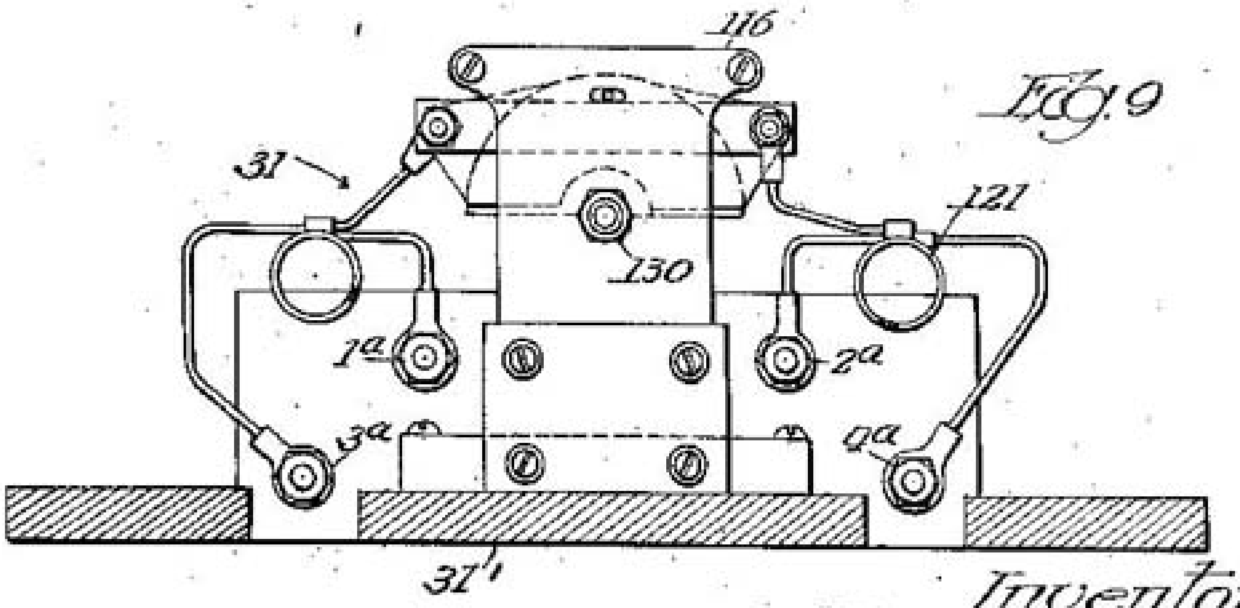


Fig. 9



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HIGH FREQUENCY APPARATUS

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Fig. 10

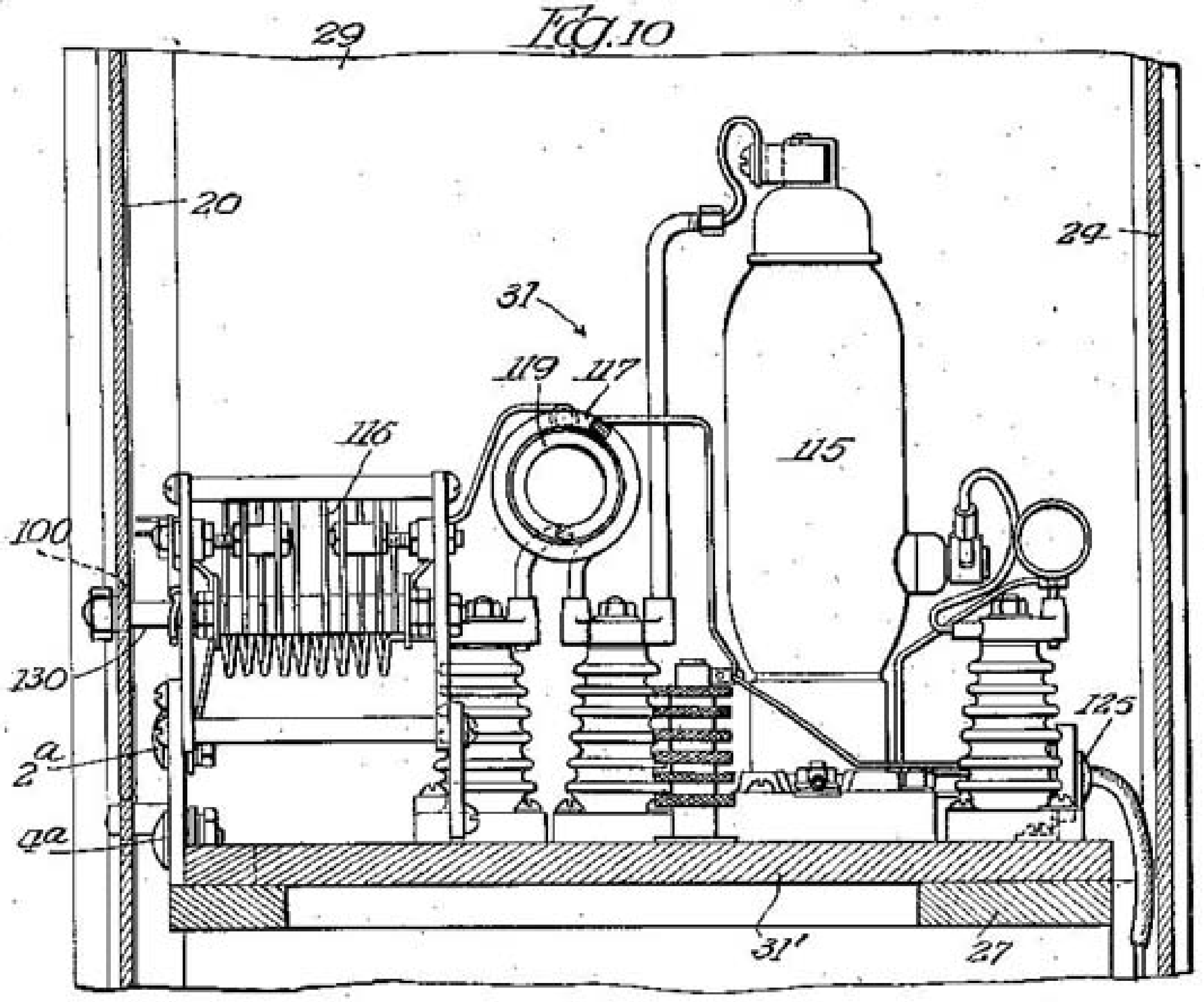


Fig. 11

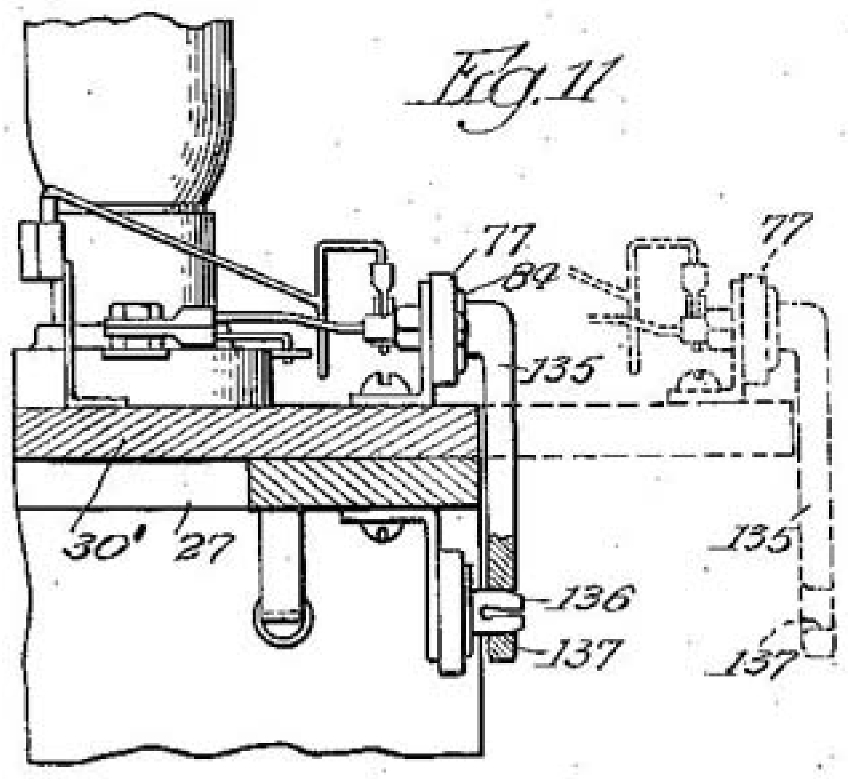
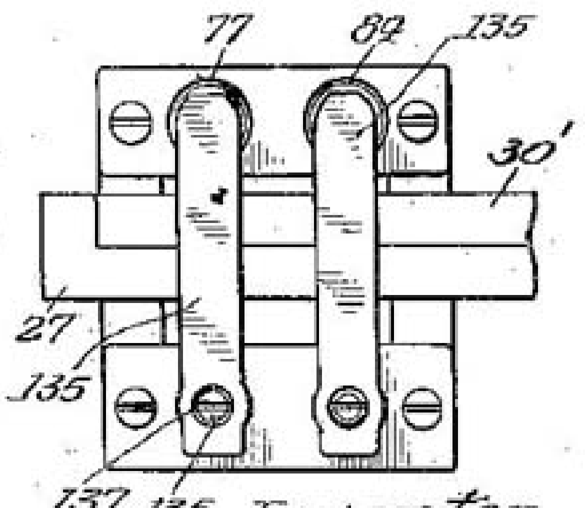


Fig. 12



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HIGH FREQUENCY APPARATUS

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Fig.15

6-METER OSCILLATOR

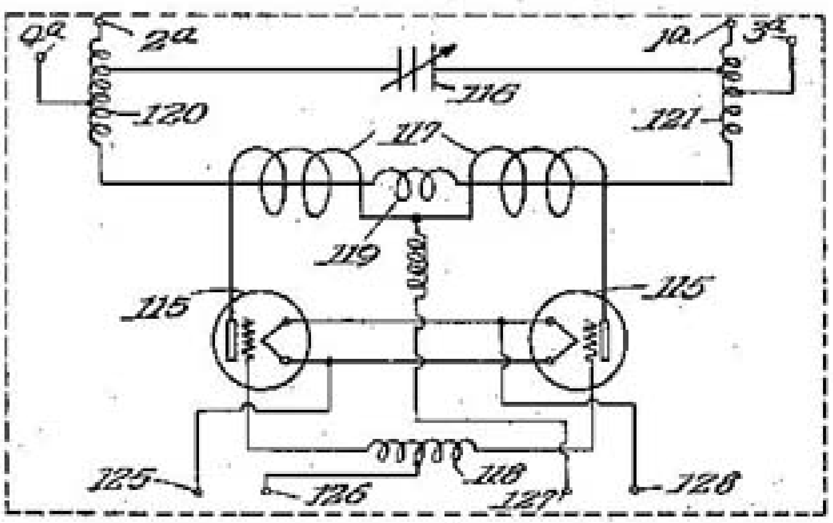


Fig.14

18-METER OSCILLATOR

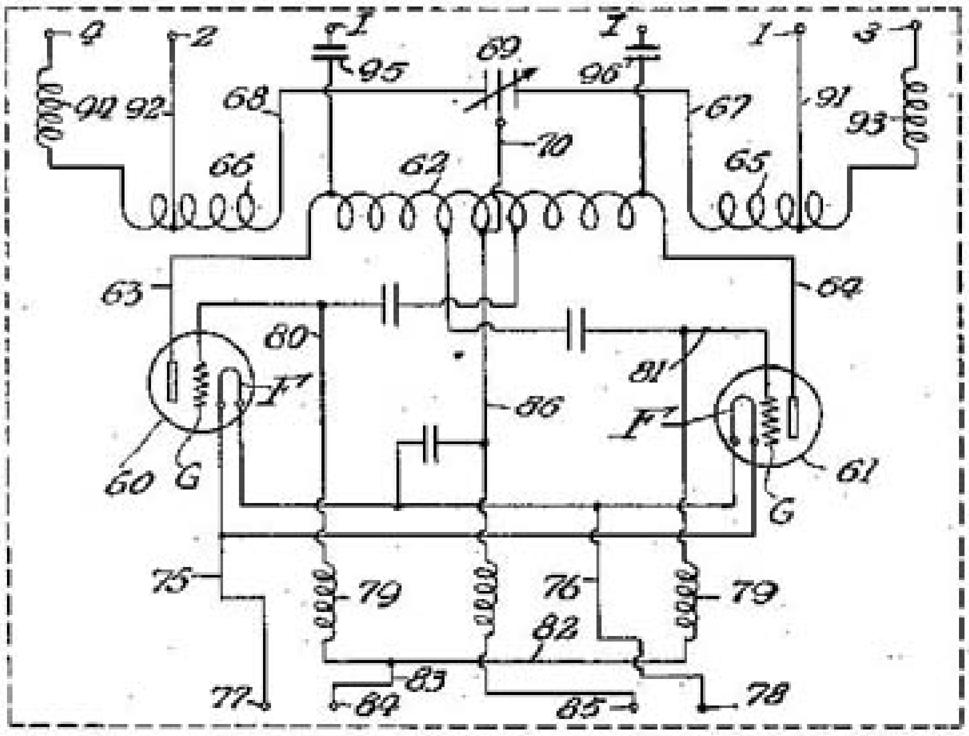
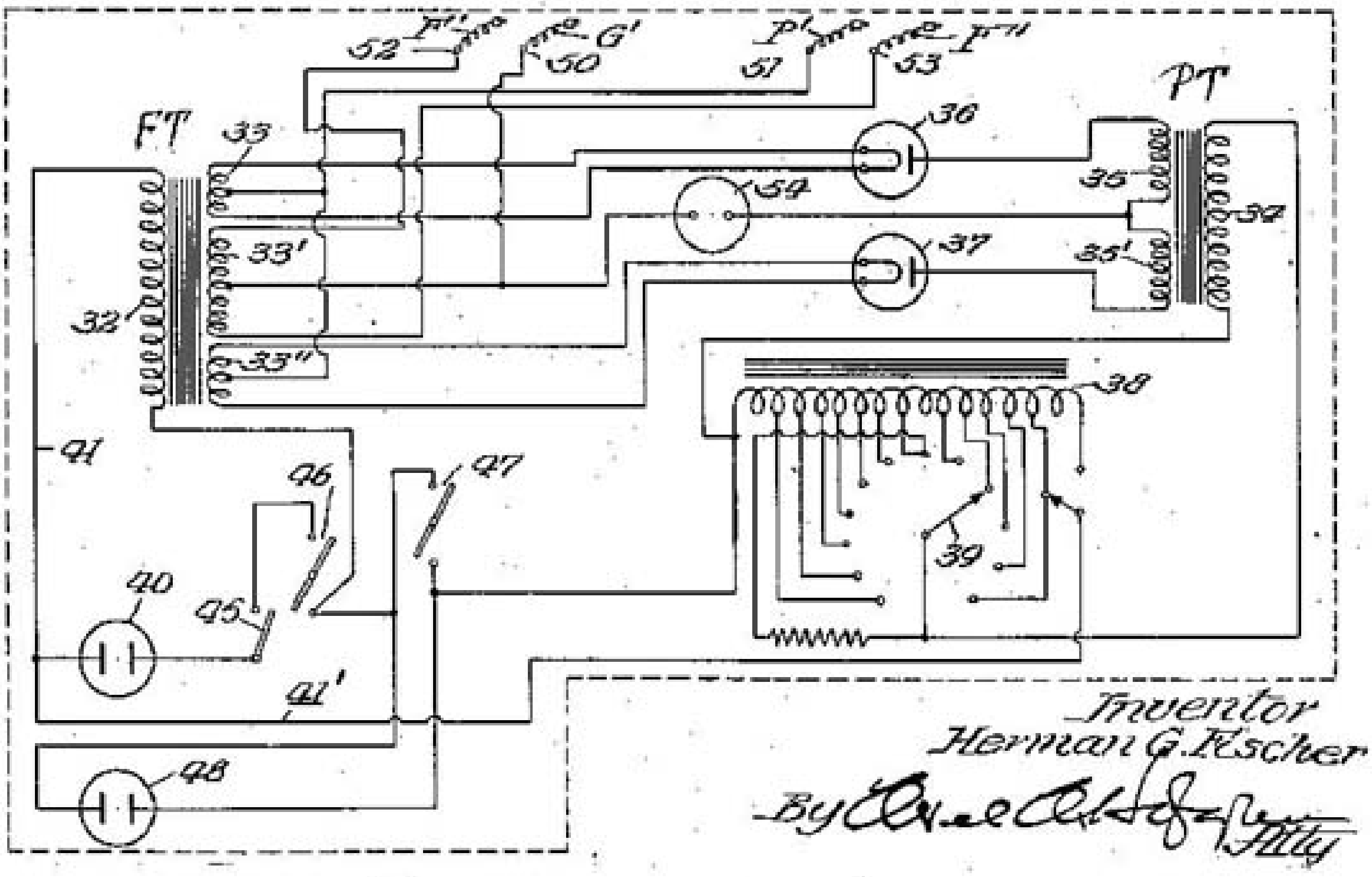


Fig.13



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Herman G. Fischer
By
Atty

Patented Apr. 25, 1939

2,155,786

UNITED STATES PATENT OFFICE

2,155,786

HIGH FREQUENCY APPARATUS

Herman G. Fischer, River Forest, Ill., assignor to
H. G. Fischer & Co. Inc., Chicago, Ill., a corporation of Illinois

Application July 9, 1936, Serial No. 89,854

10 Claims. (Cl. 128—422)

The invention relates generally to high frequency apparatus and more particularly to such apparatus adapted to be used by physicians for therapeutic and other similar purposes.

For therapeutic, surgical or similar purposes several different frequencies or wave lengths may be employed and the various elements of the apparatus for producing any particular wave length must be properly and accurately interrelated as to design and assembly. The apparatus generally comprises transforming and rectifying means arranged to supply current to an oscillator which, by its design, determines the wave length of the output current to the patient's circuit. In connection with each oscillator there is generally provided a capacity current control designed particularly for the oscillator with which it is used.

At the present time wave lengths of 6, 12, 18 or 24 meters, as well as others, are commonly employed. While any one of these wave lengths may be employed with satisfactory results for substantially all therapeutic or surgical purposes, there is an occasional swing of opinion favoring a particular wave length. At least there is a growing belief that certain wave lengths are more beneficial than others for certain treatments, or for the treatment of different portions of the body. To follow these trends in thought, a physician, at present, must have several complete machines and thus must have such a large investment in high frequency apparatus that it becomes a substantial burden which many physicians are loath to assume.

An important object of the present invention, therefore, is to obviate this necessity for such a burdensome investment by providing a new and improved high frequency apparatus wherein the various operative elements are interrelated to each other in such a manner as to permit ready disconnection and removal of the oscillator portion thereof and replacement by another oscillator arranged to supply current of a different wave length.

Another object is to provide such apparatus housed and arranged in a cabinet in such a manner as to permit withdrawal of the oscillator from the cabinet as a unit for replacement by an oscillator having different output characteristics.

Another object is to provide high frequency apparatus of this character wherein the operative elements of the device are automatically disabled as an incident to the opening of the cabinet.

Another object is to provide high frequency apparatus wherein the removable oscillator unit is automatically connected in proper relation to the power unit as an incident to the placing of the oscillator in the cabinet.

Further objects and advantages will become readily apparent from the following detailed description taken in connection with the accompanying drawings, in which:

Fig. 1 is a front elevation of a preferred form of the invention.

Fig. 2 is a section approximately along the line 2—2 of Fig. 1.

Fig. 3 is a rear view of the preferred form of apparatus with the rear cover removed.

Fig. 4 is a view similar to Fig. 2 (with the rear wall of the cabinet removed and the oscillator partly withdrawn).

Fig. 5 is an enlarged plan section approximately on the line 5—5 of Fig. 2.

Fig. 6 is an enlarged fragmentary section approximately along the line 6—6 of Fig. 3 with the rear wall removed.

Fig. 7 is a similar view with the rear wall in position.

Fig. 8 is a view similar to Fig. 5 with a different form of oscillator unit installed.

Fig. 9 is a section along the line 9—9 of Fig. 8.

Fig. 10 is a fragmentary side elevation of the oscillator unit illustrated in Fig. 8.

Fig. 11 is a fragmentary view similar to Fig. 2 and showing a modified form of connecting means.

Fig. 12 is a fragmental view of the connecting means of Fig. 11 as viewed from the right in Fig. 11.

Fig. 13 is a diagram of the power transformer, control and rectifying mechanism positioned in the lower compartment of the apparatus.

Fig. 14 is a wiring diagram of the oscillator unit illustrated in Figs. 1 to 5.

Fig. 15 is a wiring diagram of the oscillator unit illustrated in Figs. 8 to 10.

While there is illustrated in the drawings and shall hereafter be described in detail a preferred form of the invention, it is to be understood that the invention is not limited to the particular construction and arrangement shown, it being contemplated that various changes may be made by those skilled in the art without departing from the spirit and scope of the invention as expressed in the appended claims.

In the exemplary form illustrated in the drawings, the invention is herein embodied in a high frequency apparatus of the type used for therapeutic and other similar purposes. This apparatus (see Figs. 1 to 5) is contained in a cabinet 20 having a front instrument mounting panel 21, side walls 22 and 23, a rear removable wall or panel 24, a bottom board 25, a top 26 and an intermediate shelf or oscillator unit supporting frame 27. The lower compartment 28 formed intermediate the bottom 25 and the shelf 27 is herein utilized for the power transformer, control and rectifying devices illustrated diagrammatically in Fig. 13. A compartment 29 formed intermediate the shelf 27 and the top 26 of the cabinet is utilized to house one of a plurality of removable and interchangeable oscillator units of the apparatus. One form of such a unit, adapted to generate high frequency current of a wave length of approximately 18 meters is indicated at 30 in Figs. 2 to 5, while a similar unit for generating current with a wave length of approximately 6 meters is indicated at 31 in Figs. 8 to 10.

In the present form of the invention, the power transformer, control and rectifier devices are permanently mounted in the cabinet and on the control panel and consist generally (Figs. 2, 3 and 13) of a filament transformer FT having a primary 32 and secondaries 33, 33′ and 33″, a plate transformer PT having a primary 34 and secondaries 35 and 35′, a pair of rectifier tubes 36 and 37 suitably connected to said transformer secondaries, a 12-point auto transformer control having a winding 38 and a control switch having a handle 39. A suitable power supply, such as 60 cycle alternating current, may be connected to the apparatus by means of a plug receptacle 40 accessible through a suitable aperture in the back panel 24. One terminal of this receptacle is connected directly to one terminal of the filament transformer primary 32 by a wire 41 and to one end of the auto transformer winding 38 by means of a wire 41′, whereas the other terminal of the receptacle 40 is connected to the other terminal of the primary 32 through a safety switch 45 (Figs. 3, 6, 7 and 13) and a filament switch 46 (Figs. 1 and 13). A plate circuit switch 47 is suitably connected in series with switch 46 in the lead to the other terminal of the winding 38, and preferably an outlet connection receptacle 48 is connected in parallel with the late switch 47 for receiving foot switch leads. The filament switch 46 and plate switch 47 are preferably of the tumbler type illustrated, and the safety switch 45 may also be of the tumbler type and arranged to be closed by the rear panel 24 when said panel is properly installed to close the back opening in the cabinet, as hereinafter more fully described.

Power output leads from the rectifier device connect to a pair of filament terminals 50 and 51 (Figs. 2, 3 and 13), a plate terminal 52 and a grid terminal 53. Included in the connection from the midpoint of the plate transformer secondaries 35, 35′ is a milliammeter 54 (Figs. 1 to 4 and 13) which meter is preferably mounted in a fixed position on the front panel 21 to indicate the power output of the apparatus when in operation.

The oscillator unit illustrated in Figs. 1 to 5 and 14 comprises generally a pair of tubes 60 and 61, the plates of which are connected to the opposite ends of an inductance coil 62 by wires 63 and 64. A pair of laterally spaced inductance coils 65 and 66 are positioned in alinement with and at opposite ends of the coil 62. The adjacent ends of these coils are connected by wires 67 and 68 to stationary plate sections of a tuning condenser 69. The rotary plates of this condenser are connected by a wire 70 to the midpoint of the coil 62.

The filaments F of the tubes are suitably connected by wires 75 and 76 to a pair of filament terminals 77 and 78 carried on the rear portion of the base 30′ of the oscillator unit. The grids G of the tubes are connected through suitable radio frequency chokes 79 and wires 80, 81, 82 and 83 to a grid terminal 84 carried on the rear portion of the base 30′. A plate terminal 85 on the base 30′ adjacent the other filament terminal 78 is connected through a radio frequency choke and by a wire 86 to the midpoint of the coil 62.

In the present form of the invention, a plurality of output terminals are provided for the oscillator unit to facilitate attaching the electrode or patient's circuit leads. Thus, as illustrated in Figs. 5 and 14, terminals 1, 2, 3 and 4 are provided, terminals 1 and 2 being connected through suitable wires 91 and 92 to intermediate points on the coils 65 and 66, whereas terminals 3 and 4 are connected through suitable tuning coils 93 and 94 to the ends of coils 65 and 66. The form of oscillator unit illustrated in Figs. 1 to 5 and 14 also has a pair of terminals I connected through suitable protective condensers 95 and 96 to points on the coil 62 approximately one-half turn from the ends thereof. These outlet terminals I are adapted for use with a coil type of electrode for induction therapy.

As mentioned hereinbefore, the invention makes provision for the ready removal of one oscillator unit and the insertion of another into the cabinet 20 for the purpose of changing the wave length of the high frequency current. This is accomplished by arranging the front panel 21 for the reception of the control member of the tuning device of the different oscillator units as well as for the reception of the output terminals of the different units and furthermore by providing suitable and convenient means for connecting the output terminals of the rectifier unit to the input terminals of the oscillator unit. As illustrated herein, the panel 21 is provided with a suitable opening 100 (Figs. 4 and 5) through which the control member or shaft 101 of the tuning condenser projects when the oscillator unit is properly installed, the end of the shaft 101 being of irregular section so as to require the application of a manual control handle 102 in a predetermined angular position with respect to the shaft. In this way a pointer portion 102′ of the member 102 (Fig. 1) indicates on a scale 103 the angular position of the rotor of the condenser. The induction therapy terminals I project from the front panel 30″ of the unit as illustrated most clearly in Figs. 2, 4 and 5 and extend through suitable openings 104 and 105 in the panel 21 to facilitate insertion of a pair of electrode leads. The panel 21 is also provided with openings 1′, 2′, 3′ and 4′ suitably positioned so that when the oscillator unit is installed these openings are alined with the output terminals 1, 2, 3 and 4 respectively so that the connectors on the ends of the electrode leads may be inserted through the openings, 1′, 2′, etc. and into engagement with the output terminals 1, 2, etc. Preferably, an additional opening 106 is provided somewhat centrally of the panel 21 to receive a plug 107 mounted on the front panel 30″ of the oscillator unit, which plug may conveniently bear a numeral indicating the wave length of the oscillator, the wave length in Fig. 1 being indicated as 18.

To connect the output terminals of the rectifier device with the input terminals of the oscillator unit, a plurality of relatively short, flexible leads F', G' and P' are provided. The lower ends of these leads are suitably anchored to the corresponding output terminals of the rectifier device, the upper ends of these leads being provided with plug type terminals for insertion into input terminals 77, 78, 84 and 85 of the oscillator, said input terminals being preferably of a socket type. These leads are preferably short, not only to facilitate their insertion in the socket terminals, but also to require the oscillator unit to be inserted completely into the cabinet before it is possible to connect the upper ends of the leads to the socket terminals of the oscillator.

As an additional means to insure complete insertion of the oscillator unit before the unit can be operated, the safety switch 45 is so mounted in the lower portion of the cabinet 20 that the operating element 45' of the switch is engaged by an arm or bracket 45'' carried on the lower portion of the rear panel 24. Since this panel is installed by inserting dowel pins 24' (Fig. 6) in sockets 24'' in the base 25 and by attaching nut devices 110 (Fig. 2) to screw devices 111 which project from the upper portion of the cabinet and through suitable apertures in the panel 24, it will be evident that the switch 45 is not closed until the rear panel is installed. Furthermore, in order to install the rear panel, the oscillator unit must be completely inserted so that the base 30' thereof does not project rearwardly beyond the inner surface of the rear panel 24. The switch 45 is of the spring return or normally open type so that upon removal of the rear panel the switch will open automatically.

Although it is contemplated that oscillator units of any desired output frequency may be substituted in the apparatus, there is illustrated herein a single alternative oscillator unit designed to generate high frequency current of approximately 6 meter wave length. This unit, as illustrated in Figs. 8 to 10, is mounted on a removable base 31' and comprises (Figs. 8 to 10 and 15) a pair of tubes 115, a tuning condenser 116, an inductance coil 117 connected between the plates of the tubes, an inductance coil 118 connected between the grids of the tubes and an inductance coil 119, positioned within the coil 117, and also coils 120 and 121 connected to the opposite ends of the coil 119 and to output terminals 1^a, 2^a, 3^a and 4^a. The output terminals 1^a and 2^a are connected to the free ends of the coils 120 and 121; the output terminals 3^a and 4^a are connected to intermediate portions of the coils 120 and 121, and the two stationary sections of the tuning condenser 116 are connected to the coils 120 and 121 intermediate the points of connection of the output terminals. This form of oscillator unit is also provided with input terminals of the socket type mounted in pairs on the rear portion of the base 31' as shown most clearly in Figs. 8 and 9. Thus one filament input terminal 125 and a grid terminal 126 are mounted at one side of the base 31' and another filament terminal 127 and a plate terminal 128 are mounted at the other side of the base. The input terminals on this oscillator unit are preferably located in positions corresponding exactly with the positions of corresponding input terminals on the 18 meter unit.

Furthermore, the control member or shaft 130 of the tuning condenser 116 is located so as to protect through the opening 100 in the front panel 21, and the output terminals 1^a, 2^a, 3^a and 4^a of the oscillator unit are located so as to aline perfectly with the openings 1', 2', 3' and 4' respectively in the front panel 21.

In order to remove one oscillator unit from the cabinet, it is merely necessary to remove the handle 102 of the tuning condenser from the condenser shaft and then, after removing the rear panel 24, disconnect the leads F', G', P' and F' from the oscillator input terminals. The oscillator unit may then be withdrawn rearwardly on its base 30' as illustrated in Fig. 4, and removed from the cabinet. Thereafter, another oscillator unit such, for example, as the one illustrated in Figs. 8 to 10 may be moved into the upper compartment of the cabinet from the rear by sliding the base 31' thereof onto the shelf 27 so that the tuning condenser shaft 130 projects through the panel 21. Since the ends of the shafts of the tuning condenser on the various oscillator units are also formed with the same irregularity, the application of the control handle 102 to the front of a condenser shaft will cause the pointer portion 102' to indicate the location of the rotor section of the condenser for each unit. Thereafter, by connecting the leads F', G' etc. to the input terminals of the oscillator unit, the rear panel 24 may be properly installed to close the back of the cabinet and close the safety switch 45, thus placing the apparatus in condition for operation.

In Figs. 11 and 12 of the drawings there is illustrated a high frequency apparatus having an alternative form of connecting means for establishing the electrical connection between the output terminals of the power unit and the input terminals of the oscillator. By this form of connecting means the desired electrical circuits are established automatically as the oscillator is moved forward on the shelf 27 to its operative position in the cabinet. Thus, as shown in Figs. 11 and 12, a relatively rigid switch member 135 is secured to each of the input terminals 77, 78, 84 and 85 of the oscillator, so as to depend from the rear edge of the oscillator base and past the supporting shelf 27. In corresponding positions on the lower rear edge of the shelf 27, a plurality of complemental spring clips or contacts 136 are mounted so that as the oscillator is moved forwardly into its operative position in the cabinet, suitable openings 137 in the several switch members 135 will be engaged with the corresponding contacts 136. The contacts 136 are connected to the terminals 50, 51, 52 and 53 so that when the switch members 135 and 136 are thus connected, the oscillator is conditioned for operation.

By reason of the provision of apparatus constructed to permit ready removal and replacement of the oscillating unit, the present device may be purchased by users with the assurance that any change in operative technique may be followed at a nominal cost. Moreover, the maker is able, with the present device, to fill orders promptly without necessity for carrying a large inventory.

In the substitution of various oscillator units, the connections to be effected are of a simple character so that they may be made by relatively unskilled help, and the safety switch means acts invariably to protect the person making such changes. Since the connections between the input and output terminals can be made only after the oscillator is in its proper position in the cabinet, proper performance of the device is assured.

I claim as my invention:

1. High frequency apparatus comprising, in combination, a cabinet having a front wall with a control panel therein and a removable back wall, said control panel having a plurality of openings therein, an oscillator unit having patient's terminals and a tuning means with a manual control element therefor, said terminals and said control element being located on one side of said unit, means for supporting and guiding said unit for movement through the back of said cabinet forwardly toward said panel to register said terminals and said control element each with one of said openings, transforming and rectifying means mounted within said cabinet, and means located within and adjacent the back of said cabinet for establishing operative connection between said transforming and rectifying means and said unit.

2. High frequency apparatus comprising, in combination, a cabinet having a front control panel, an open back, a panel for closing said open back, and means for supporting a power unit and an oscillator unit in predetermined adjacent positions in said cabinet, a power unit permanently mounted in said cabinet and having power output terminals disposed in spaced relation along and adjacent to the line of division between the oscillator unit and said power unit, an oscillator unit removably mounted in said cabinet and having correspondingly arranged input terminals, said input and output terminals being located adjacent to said open back of the cabinet and adjacent to each other, and means for connecting said input and output terminals.

3. High frequency apparatus comprising, in combination, a cabinet having a control panel in one side thereof and a removable side wall, said panel having a plurality of openings formed therein, a current indicating device permanently mounted on said panel, transforming and rectifying means permanently mounted in said cabinet, an oscillator unit having patient's terminals on one side of said unit and a tuning means for said unit, an operating element for said tuning means positioned on the same side of the unit as said terminals, said unit being adapted to be positioned with the terminal side facing the inside surface of said panel and being movable in this position into the cabinet when said side wall is removed, means for supporting and guiding said unit in such movement to register said element and said terminals with said openings upon completion of such movement, detachable means for connecting said transforming and rectifying means with said unit to supply power thereto, and means permanently connecting said transforming and rectifying means with said indicating device to operate said device in accordance with the current flowing through said patient's terminals.

4. High frequency apparatus comprising, in combination, a cabinet having a front control panel, a removable back wall and an intermediate shelf dividing said cabinet into upper and lower compartments, a power unit mounted in said lower compartment with a control element and an indicator element permanently associated therewith and mounted on said front panel, said panel having a plurality of openings therein, an oscillator unit adapted to be inserted forwardly through the open back of said cabinet and having a control element and a plurality of terminals disposed for registry with said panel openings, a plurality of power output terminals for said power unit disposed along the lower rear edge of said shelf, and said oscillator unit having a plurality of input terminals correspondingly arranged to be positioned along the upper rear edge of said shelf, and means for detachably connecting said output and input terminals.

5. High frequency apparatus comprising, in combination, a cabinet having a front control panel and an open back, a removable closure for said back, a power unit mounted in said cabinet adjacent to one portion of said front panel and having a control element mounted on said portion of the panel, an oscillator unit positioned in said cabinet adjacent to a second portion of said panel, said oscillator unit being withdrawable from said cabinet by movement rearwardly away from said panel and through said open back, said units having similarly positioned terminals disposed at spaced points along their adjacent rear edges, means for detachably connecting the corresponding terminals of said units, said second portion of said panel having a plurality of openings formed therein, and said oscillator having a tuning element alined with one of said openings and a plurality of patient's terminals, each alined with one of the other openings.

6. High frequency apparatus comprising, in combination, an upright cabinet having a front control panel, a rear wall having an opening therein and a partition dividing the cabinet into a lower and an upper compartment, transforming and rectifying means disposed in said lower compartment and having power output terminals, an interchangeable oscillator unit removably inserted as a unit through the opening in the rear wall and supported on and guided by said partition, said oscillator unit having power input terminals disposed at the rear of the unit to be accessible through the opening in the rear wall, and short flexible leads each connected at one end to one of the output terminals and long enough to be connected with one of the input terminals only when said oscillator unit is properly inserted.

7. High frequency apparatus comprising, in combination, a cabinet having a fixed front panel and a rear wall movable to open the rear side of the cabinet, transforming and rectifying means mounted in said cabinet, a power supply circuit including a switch biased to open position connected to said means, power output terminals leading from said means, an oscillator unit adapted to be removably positioned in an operating position within said cabinet and having input terminals, means carried by said oscillator unit adapted automatically to connect said input and said output terminals as an incident to positioning of said oscillator unit within said cabinet, and means on said rear wall cooperating with said switch and adapted to close the same to render the apparatus operative upon moving the wall to closed position.

8. In a high frequency apparatus for therapeutic and surgical use, a cabinet having a control panel on one side and an opening in another side, said panel having apertures therein, an oscillator unit including a tuning means removably mounted in said cabinet for withdrawal and replacement as a unit through the opening, a control member for said tuning means and patient's terminals on said unit adapted to project through the apertures in said control panel when said unit is positioned within the cabinet, and an actuating member removably attachable to the projecting end of said control member.

9. High frequency apparatus comprising, in

May 25, 1926.

1,585,970

H. G. FISCHER

INDIRECT FULGURATION ELECTRODE

Filed May 21, 1923

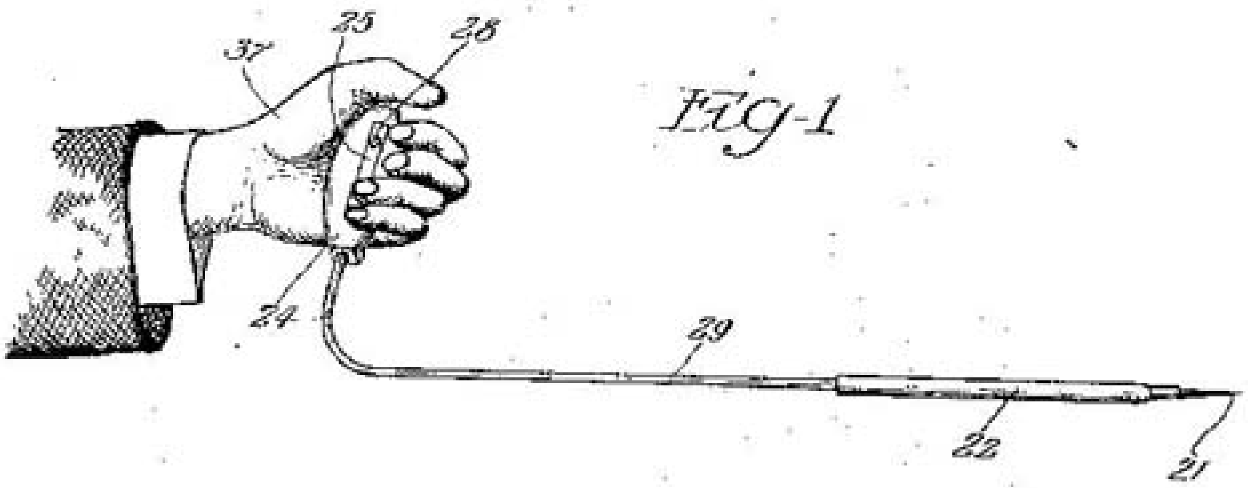


Fig-2

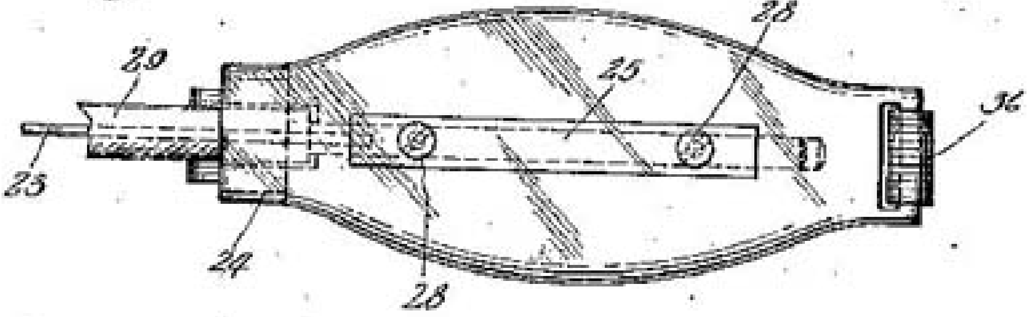
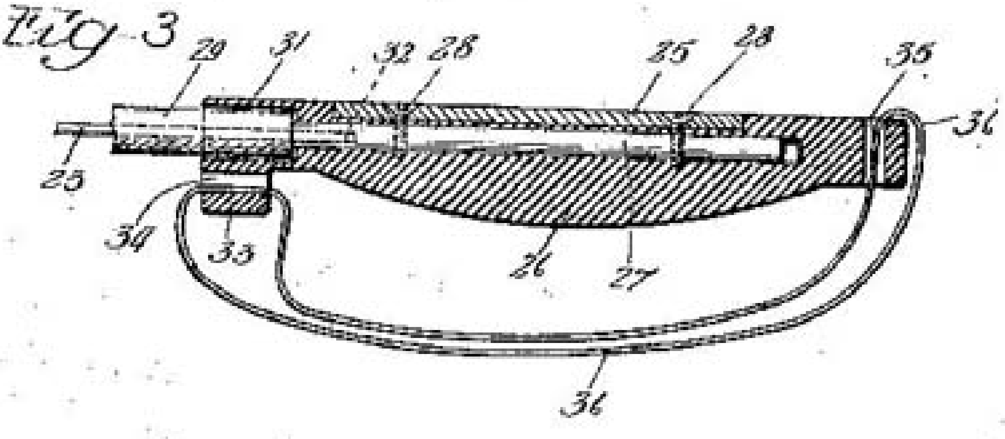


Fig-3



Inventor:
Herman G. Fischer

By:- Munday, Clarke & Carpenter, Atty's.

for the other end of the casing, current influencing means mounted on the cap, a member at the end of said means to fit against the shoulder, a socket holder mounted on said member to fit in the hole in the nose, and means to mount the cap on the casing to hold said member against said shoulder, the electrode being adapted for insertion into the hole in the nose to be engaged by the holder.

4. In a therapeutic device of the character described having a casing and an electrical coil therein with a core and a holder for an electrode, the core having electrical contact with the holder, and means to mount the holder at the end of the core whereby a removal of the coil from the casing removes the holder, said means serving as a clamping abutment for the coil within the casing.

5. In a therapeutical device of the character described having a casing and an electrical coil therein with a core and a holder for an electrode having electrical contact with the core, a terminal member for the coil with a hole therein, the core being alined with said hole, means to secure the holder to the core against said member, said means extending into the hole in the member to connect electrically the holder and the core, and providing an abutting surface for the coil within the casing.

In testimony whereof we have hereunto affixed our signatures.

THEODORE MUELLER.
THEODORE S. LORENZE.

Patented Feb. 3, 1925. **1,524,876**

UNITED STATES PATENT OFFICE.

THEODORE MUELLER AND THEODORE S. LORENZE, OF CHICAGO, ILLINOIS, ASSIGNORS TO THE MASTER ELECTRIC COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

HOLDER FOR TERMINALS OF VIOLET-RAY APPARATUS.

Application filed September 8, 1922. Serial No. 586,843.

To all whom it may concern:

Be it known that we, Theodore Mueller and Theodore S. Lorenze, citizens of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Holders for Terminals of Violet-Ray Apparatus, of which the following is a specification.

This invention relates to electro-therapeutical instruments. It is concerned particularly with the provision of a holder for the terminals or electrodes of violet ray apparatus and the like.

Instruments of this character are used extensively in administering electric treatments for a variety of ailments and diseases and operate with glass electrodes of different shapes and sizes suited to the special requirements of different kinds of cases. These electrodes being relatively fragile are frequently broken despite careful manipulation either by the terminal of the electrode binding in its holder when it is sought to remove the electrode or by dropping the instrument or in divers other ways. It was rather difficult to remove the terminal piece thus left lodged in the instrument because the same could not be gotten at very well due to the fact that the terminal holder was usually a permanently assembled part of the instrument and could not therefore be removed to afford access to the terminal piece. It is one of the principal objects of the present invention to avoid this difficulty by providing a novel arrangement in the instrument whereby the holder for the electrode terminal may be removed with facility to permit easy access to the terminal piece in the holder and thus to effect its removal.

Another object is to provide a novel construction for the holder whereby it is possible to eject the terminal piece by inserting a tool into the holder behind the piece to dislodge it.

These and other objects attained by the construction and arrangement of the present invention will be made to appear in the following detailed description.

In the drawing illustrating the invention, Figure 1 is a section through a violet ray instrument embodying our improved construction for the holder and the arrangement thereof as a part of the mechanism of the instrument. Fig. 2 is a fragmentary enlarged elevation of the end of the instrument in which the electrode is mounted. Fig. 3 is a fragmentary detached elevational detail of the holder with an electrode terminal therein, and Fig. 4 is a view of the same part in section and on an enlarged scale, the terminal being shown in elevation.

Throughout the following description the same numerals will be applied to corresponding parts.

Violet ray apparatus of the types now commonly available are usually operated by connection with an ordinary lamp socket. The extension cord shown at 10 is arranged to supply current intermittently to the current-influencing means indicated generally at 11, the particular details of which it will not be necessary to describe. It will suffice to state that the current to the influencing means 11 is interrupted by the interrupter vibrator 12 which may conveniently be adjustable as to frequency by an adjusting screw 13. In the operation of the vibrator a continuous stream of sparks is discharged from the filament of the electrode 14. The sparks, which are violet in color, penetrate the wall of the electrode and when discharged on the affected parts, have been found to produce beneficial results in the treatment of chronic nervous and muscular conditions.

The foregoing description will suffice to give a general impression of the kind of instrument with which the present invention is concerned.

Instruments of this kind at present available frequently have the current-influencing means and the vibrator removable from its casing for the purpose of inspection or repair. The holder or socket for the electrode terminal, however, as a general rule, was a fixed part of the instrument and could not be removed. The electrode 14, of which many different shapes and sizes are used in practice, are relatively fragile and, despite careful handling, frequently are broken either in removing the electrode to replace it with another electrode of a different kind or when the instrument is laid or dropped carelessly. In such event the terminal piece 15 was left lodged in the holder. The latter, being a permanent part of the instrument, could not be removed to permit the removal of the terminal piece. It was therefore a tedious operation to remove the terminal piece by probing or prying about in the broken off end thereof. There was also the likelihood of injury by being cut by the jagged, broken-off end of the bulb of the electrode.

In the present invention this difficulty is obviated by mounting the holder 16 for the electrode with the current influencing means 11 and the vibrator 12 as a unit upon the cap 17 threaded in the open end of the casing 18. The holder 16 fits loosely in the bore 19 of the neck portion 20 of the casing 18 to permit a certain degree of freedom of movement of the electrode so that it will not be so easily broken if jarred. In the construction provided, the nose 20 having the opening 19 smaller than the interior of the casing 18 forms a shoulder 20^a between which and the cap 17, the mechanism within the casing is compressed. The holder 16 has suitable electrical connections with the current influencing means preferably by means of a metallic core 21 (see Fig. 4). The casing 18 is hollow and serves to house the current influencing means and its vibrator and also serves as a handle for manipulating the electrode in treating the patient. It will be appreciated that in the event the electrode 14 is broken, the cap 17 may be unscrewed to remove the electrical mechanism with the holder 16 to afford easy access to the terminal piece 15 left lodged in the holder. Thus the piece can be removed quite easily to be replaced by another electrode.

We prefer to provide a special construction for the holder to facilitate dislodging the terminal piece. The holders are usually of the type which afford a friction grip on the terminal portion of the electrode, the electrode being inserted by straight longitudinal movement into the holder. Commonly such holders were formed with inturned edges at the mouth thereof as shown at 22 to snap over the ridge at the junction of the terminal piece with the stem of the electrode. The friction grip was produced in various manners and frequently was the cause of the terminal binding when it was sought to remove the electrode. According to the present invention the holder 16 is made tubular and soldered or otherwise made integral with a metallic cap 23 fastened by means of the screw 24 threaded into an internally threaded socket in the end of the core 21. The core 21 is illustrated as projecting through a central opening in the wooden disk 25, and in order to prevent the holder 16 from turning relative thereto, we prefer to provide two or more pins 26 projecting from the inner face of the ring 23 into the disk 25. The wall of the holder is provided with a longitudinal slot 27 which may be made to extend the entire length of the holder or at least slightly beyond the depth to which the terminal piece extends into the holder in order to afford a substantial opening therebehind through which a tool may be inserted to dislodge the piece from the holder. To further facilitate entering a tool into the holder behind the terminal piece, we prefer to provide an intersecting transverse slot 28. A tongue 29 is thus formed on one side of the slot 27 which is adapted to serve as a spring tongue for frictionally engaging the side of the terminal piece when entered in the holder. Thus the slots in the holder serve a double purpose. They serve to admit a tool into the holder for ejecting the terminal piece and also define a spring tongue for gripping the terminal piece when it is introduced into the holder.

It will be apparent from the foregoing description that the construction and arrangement of the present invention obviate the difficulty arising from the constructions employed in the earlier forms of violet-ray apparatus. In the accompanying claims it is sought to cover all modifications and adaptations of the invention which would occur to one skilled in the art to which the invention relates.

We claim as our invention:

1. An electro-therapeutical instrument of the character described having, in combination, a tubular casing having a nose at one end thereof with a hole therein axial of the casing, a cap for the other end of the casing, current influencing means mounted on said cap to fill the casing, an electrode holder mounted at the end of said current influencing means to extend into the hole in the nose, and an electrode to be mounted in the holder.

2. An electro-therapeutic device of the character described having, in combination, an electrode, a casing having a hole in one end thereof and a screw-threaded opening at the other end, and contents for the casing associated rigidly in axial alinement, said contents comprising a screw-cap for said threaded opening of the casing, current influencing means mounted on the cap, an electrode holder mounted on the current influencing means, the end of said holder being within the casing axially alined with said hole therein, the electrode being adapted for insertion through the hole to be grasped by the holder.

3. An electro-therapeutic device of the character described having, in combination, an electrode, a casing having a nose thereon at one end, the nose having a hole therein smaller than the interior of the casing whereby a shoulder is formed, and contents for said casing associated rigidly in axial alinement, said contents comprising a cap

Feb. 3, 1925. 1,524,876

T. MUELLER ET AL

HOLDER FOR TERMINALS OF VIOLET RAY APPARATUS

Filed Sept. 8, 1922

FIG. 1

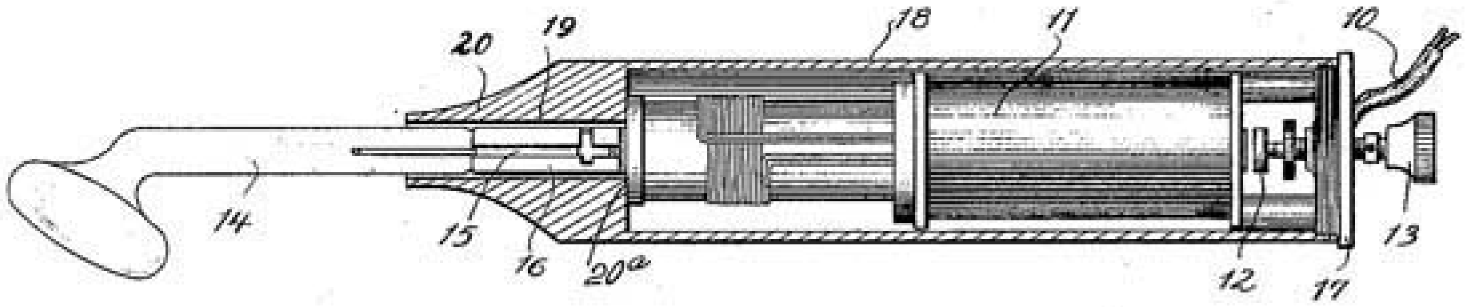


FIG. 2

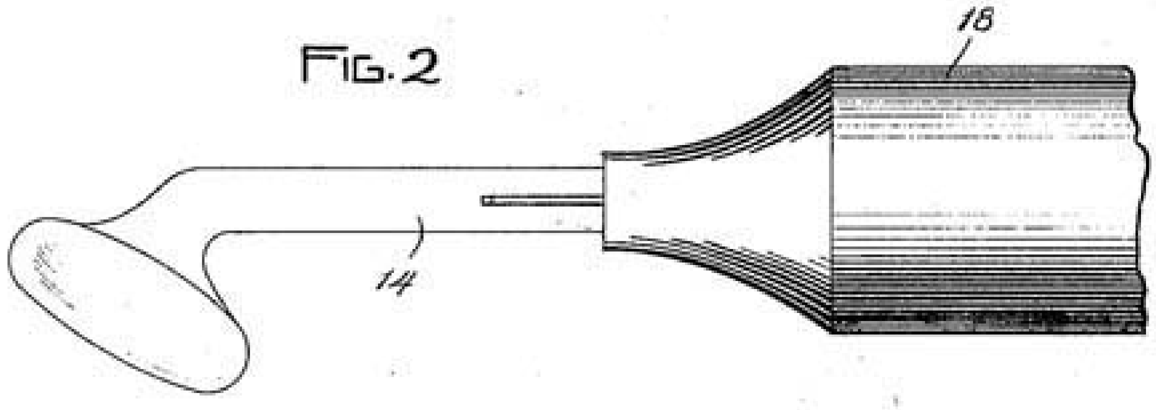


FIG. 3

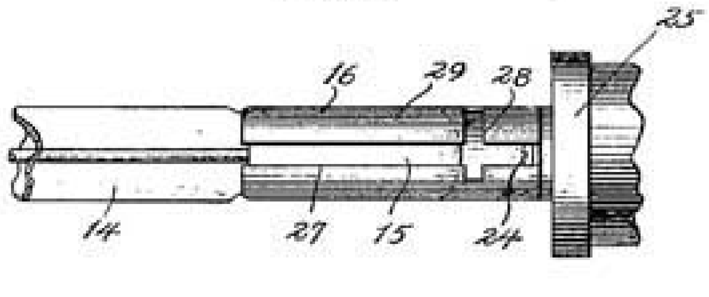
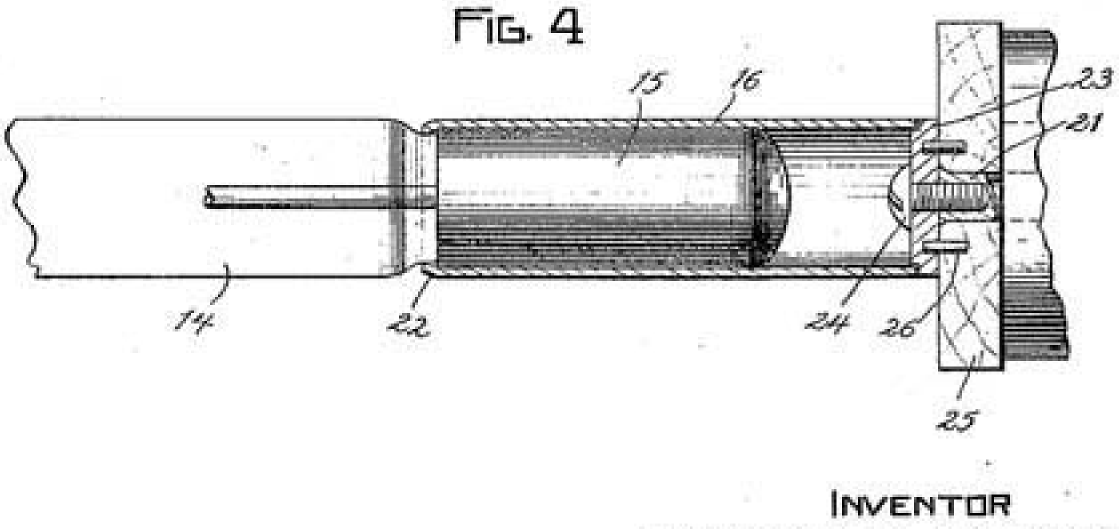


FIG. 4



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nected with one terminal of a source of high frequency current of the d'Arsonval type, and an active electrode comprising an insulated metal rod exposed at its end for application to tissue to be coagulated and for connection with a second electrical conductor connected with the other terminal of said source of current, said electrodes being independent of each other mechanically and cooperating in the hands of an operator to effect tissue retraction and coagulation of limited tissue areas adjacent the active electrode, whereby separation and retraction of the tissues may be effected by the inactive electrode independently of the active electrode and for any tissue retracting and separating position of said inactive electrode, cooperation of said electrodes may be had to coagulate desired tissue.

2. Means for retracting and coagulating tonsillar tissue, consisting of the combination of an inactive metal electrode having a rigid ring portion of metal for retracting tonsillar tissue and for connection with a first electrical conductor connected with one terminal of a source of high frequency current of the d'Arsonval type, and an active electrode comprising an insulated metal rod exposed at its end for application to tissue to be coagulated and for connection with a second electrical conductor connected with the other terminal of said source of current, said electrodes being independent of each other mechanically and cooperating in the hands of an operator to effect tissue retraction and coagulation of limited tissue areas adjacent the active electrode, whereby separation and retraction of the tissues may be effected by the inactive electrode independently of the active electrode and for any tissue retracting and separating position of said inactive electrode, cooperation of said electrodes may be had to coagulate desired tissue.

3. Means for retracting and coagulating human tissue, consisting of the combination of an inactive metal electrode having a rigid tissue retracting portion of metal for connection with a first electrical conductor connected with one terminal of a source of high frequency current of the d'Arsonval type, and an active electrode comprising an insulated metal rod exposed at its end for application to tissue to be coagulated and for connection with a second electrical conductor connected with the other terminal of said source of current, said electrodes being independent of each other mechanically and cooperating in the hands of an operator to effect tissue retraction and coagulation of limited tissue areas adjacent the active electrode, whereby separation and retraction of the tissues may be effected by the inactive electrode independently of the active electrode and for any tissue retracting and separating position of said inactive electrode, cooperation of said electrode may be had to coagulate desired tissue.

LEON LEO DOANE.

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ELECTROTHERAPEUTIC MACHINE

Filed Oct. 26, 1928 6 Sheets-Sheet 2

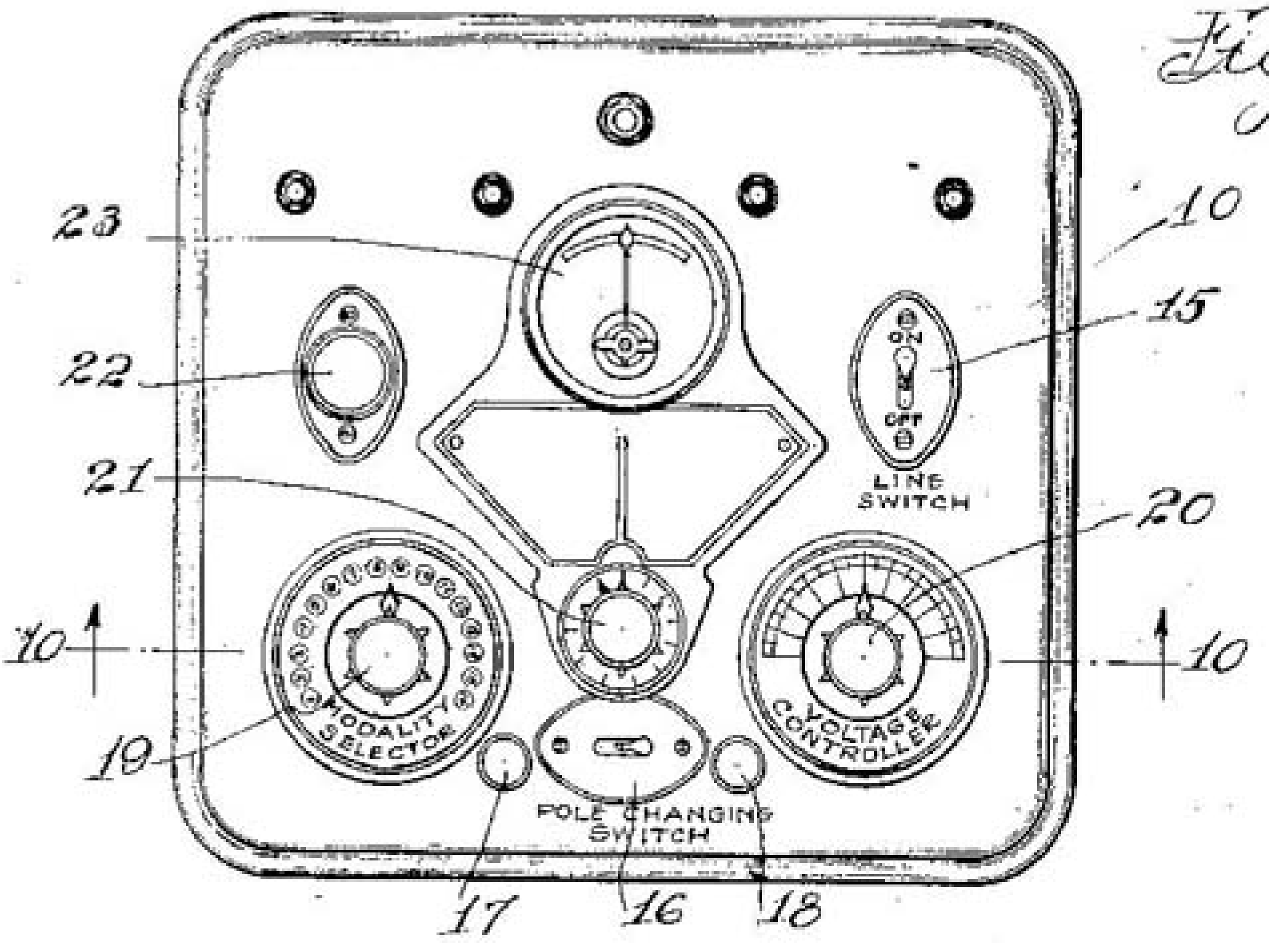

Fig. 2

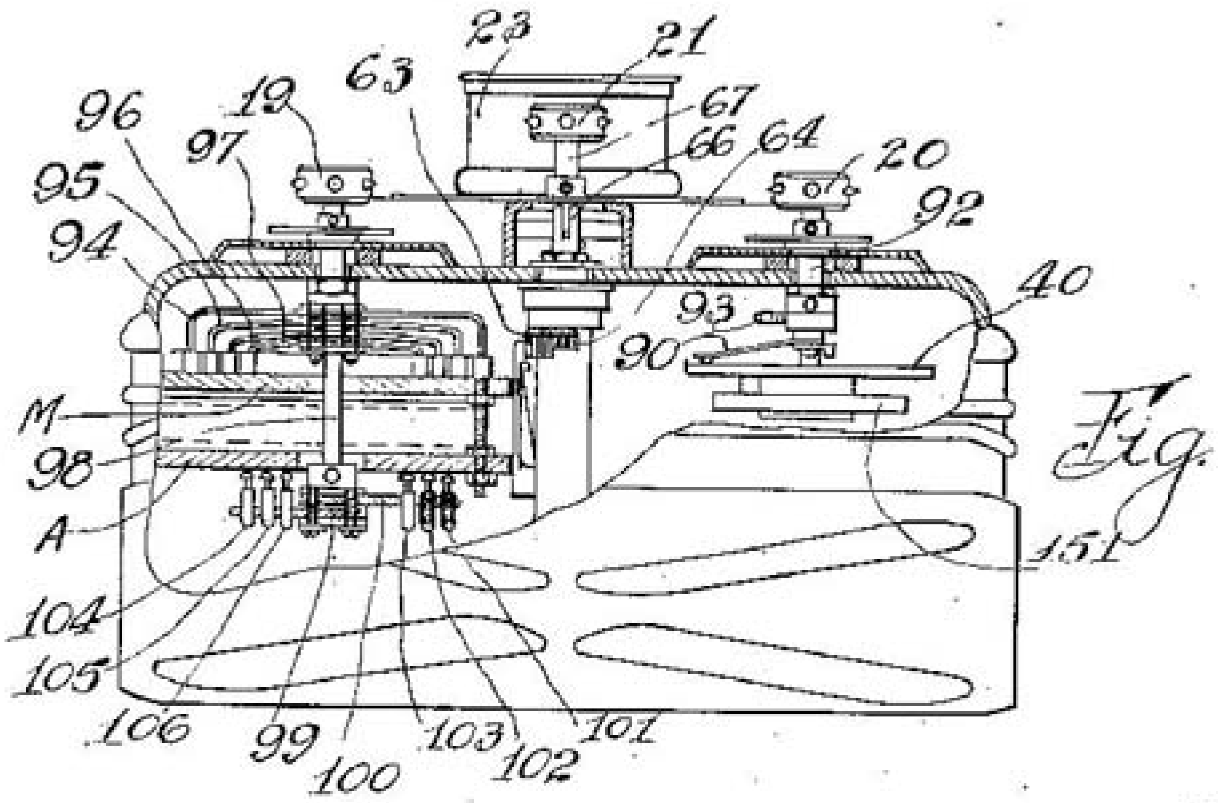

Fig. 10

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ELECTROTHERAPEUTIC MACHINE

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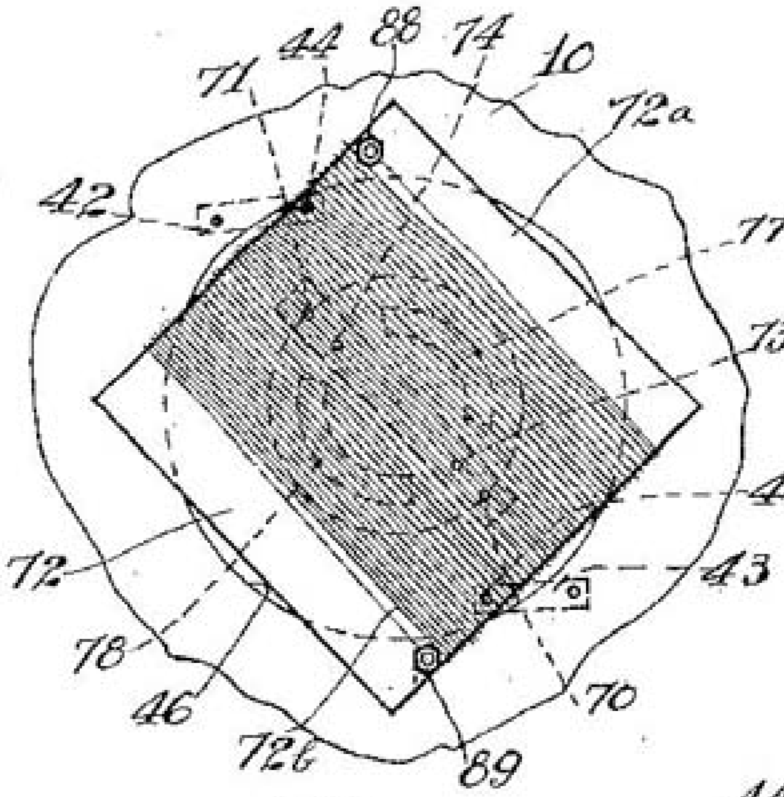

Fig. 8

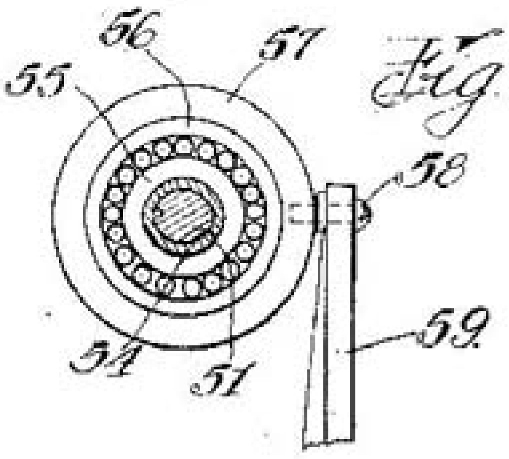

Fig. 7

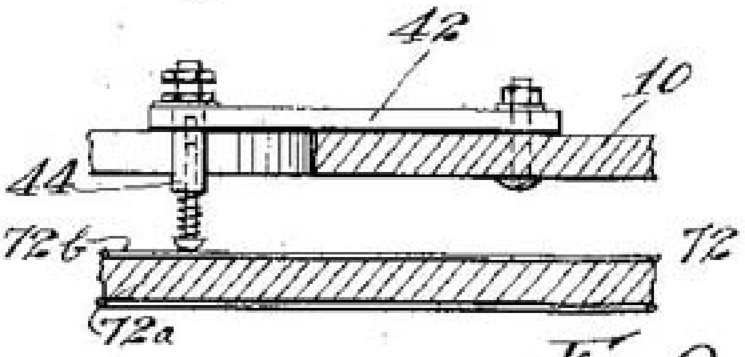

Fig. 9

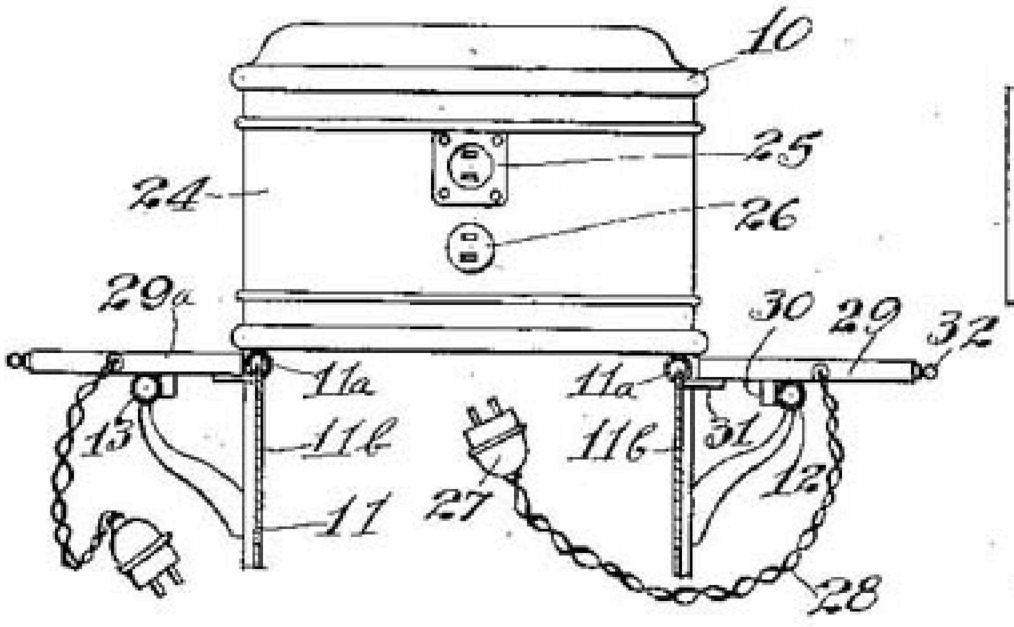

Fig. 3.

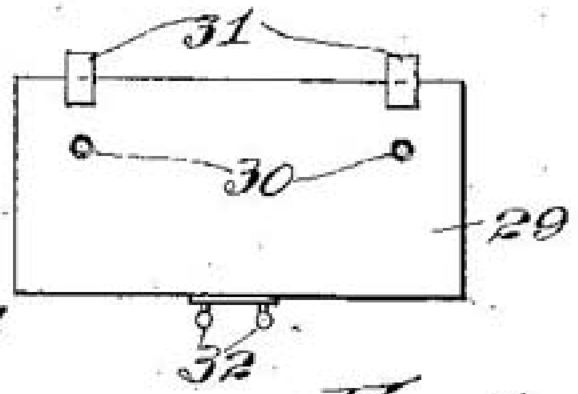

Fig. 4.

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ELECTROTHERAPEUTIC MACHINE

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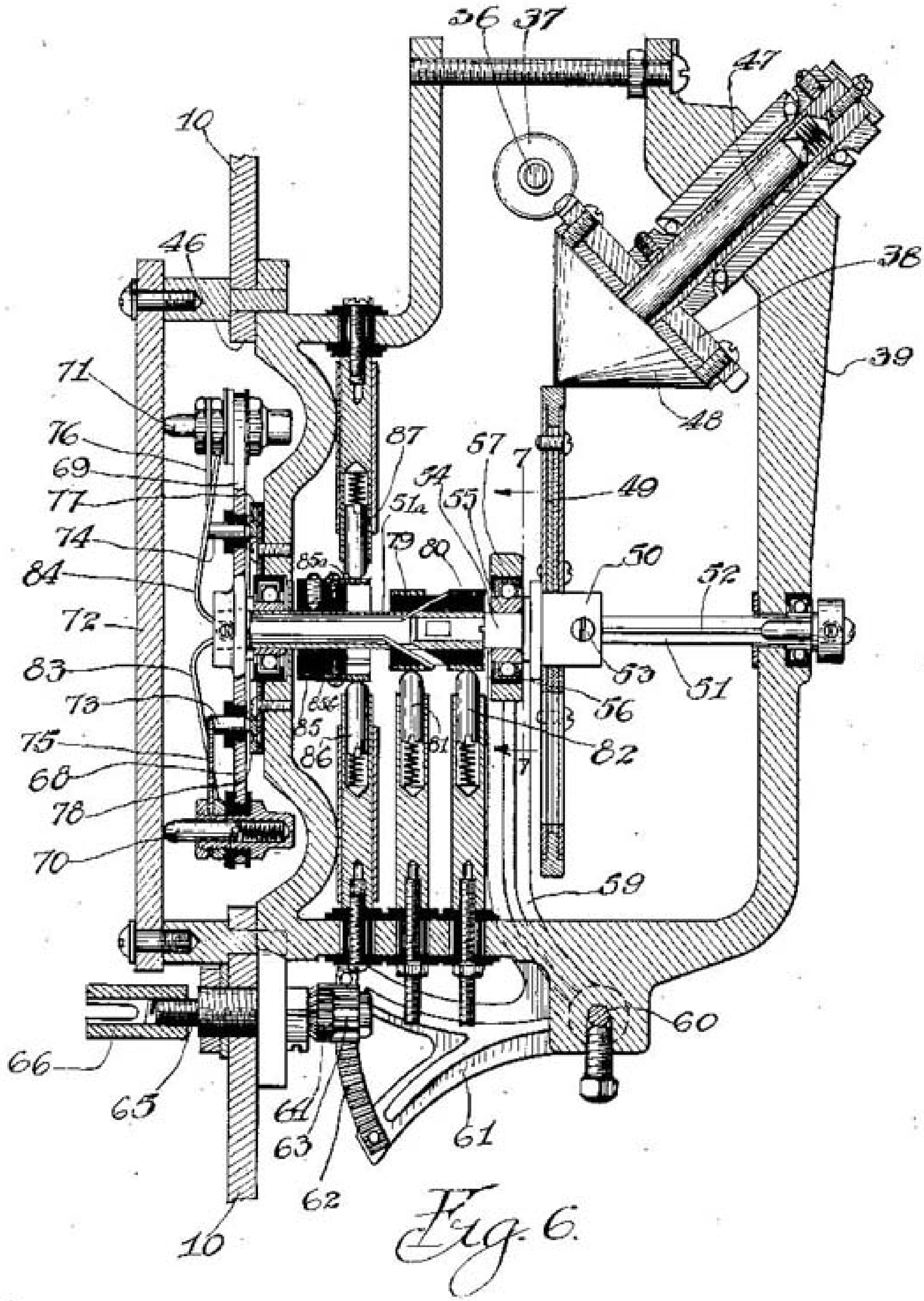

Fig. 6.

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ELECTROTHERAPEUTIC MACHINE

Filed Oct. 26, 1928 6 Sheets-Sheet 5

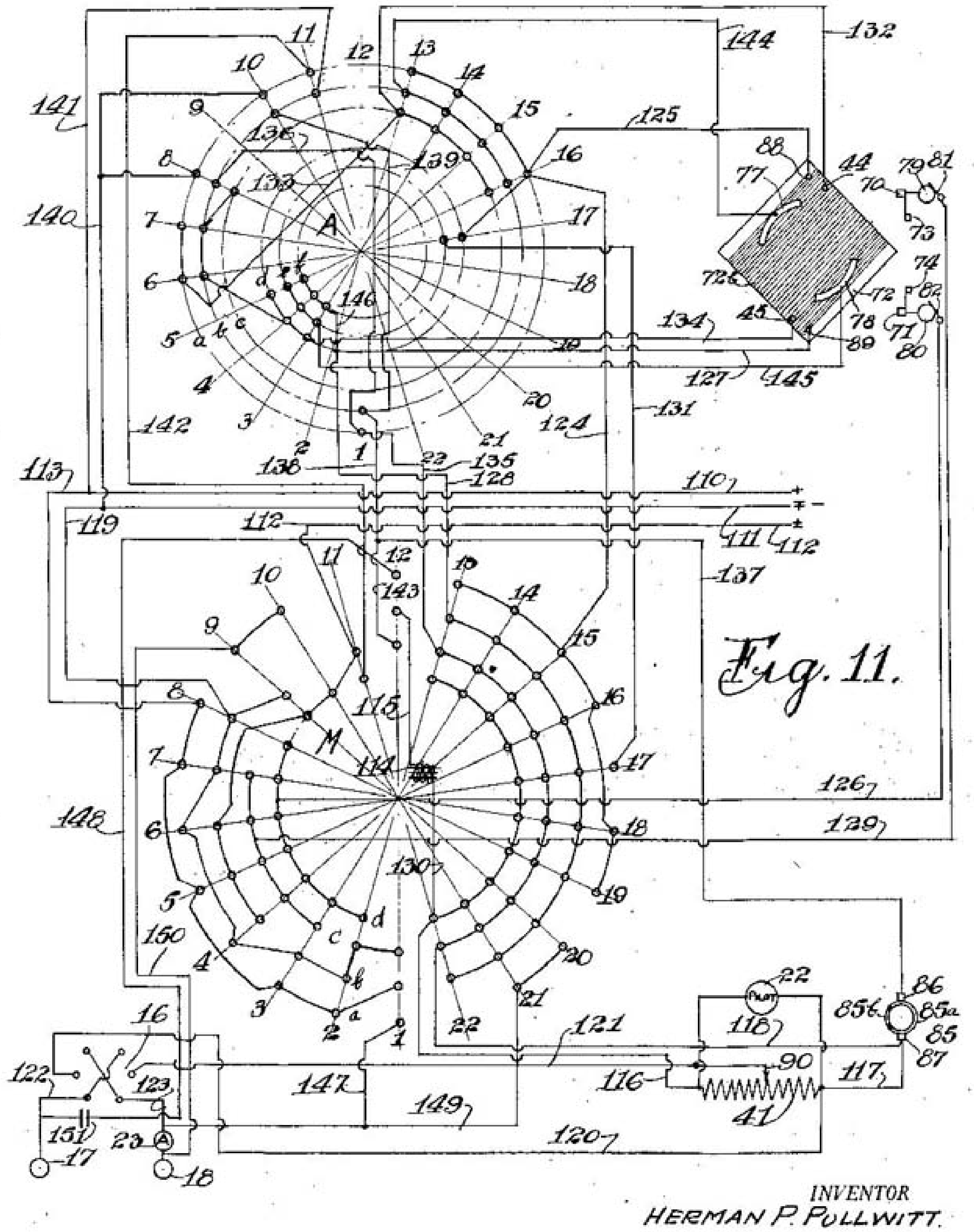

Fig. 11.

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June 17, 1930. H. P. PULLWITT 1,764,347

ELECTROTHERAPEUTIC MACHINE

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Fig 12

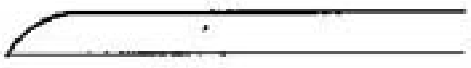


Fig. 13

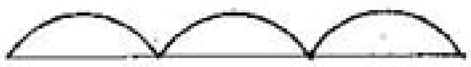


Fig. 14

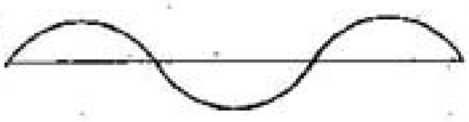


Fig. 15

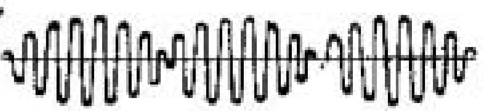


Fig 16

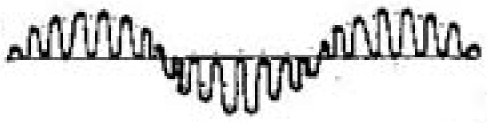


Fig. 17

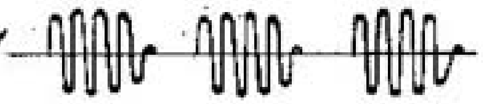


Fig. 18.

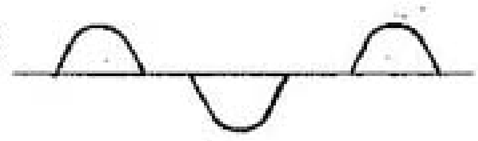
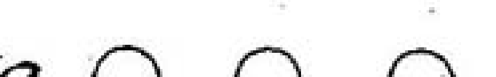


Fig. 19.



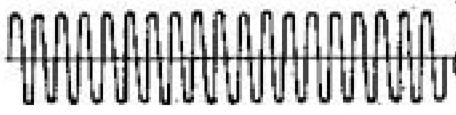


Fig. 20

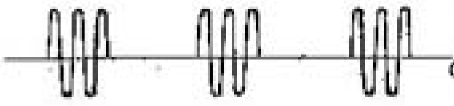


Fig. 21

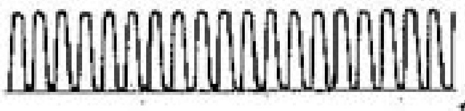


Fig. 22.

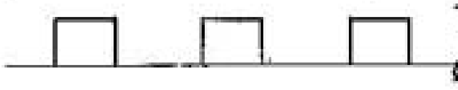


Fig. 23.

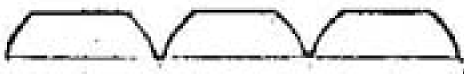


Fig 24

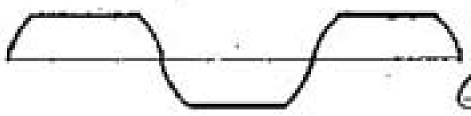


Fig. 25.

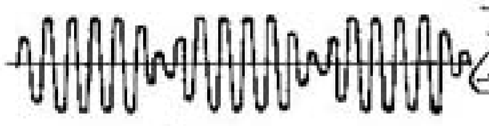


Fig. 26.

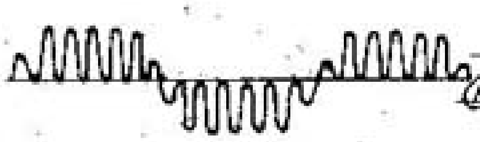


Fig. 27.

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Patented June 17, 1930

1,764,347

UNITED STATES PATENT OFFICE

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ELECTROTHERAPEUTIC MACHINE

Application filed October 26, 1928. Serial No. 315,139.

My invention relates to an improved electro-therapeutic machine for delivering to a patient's circuit, various modalities of electric current, for example galvanic current, slow sinusoidal current, rapid sinusoidal current and combinations of the same, depending upon the stimulating and tonic effect desired.

In my machine I provide devices for generating direct current and alternating current, devices for producing slow sinusoidal current, devices for changing the frequency of the slow sinusoidal current as desired, switching mechanism for selectively connecting the circuits of the machine to communicate direct or galvanic current, alternating current, slow sinusoidal current of a desired frequency, or a combination of these current modalities to the patient's circuit as desired, and in addition, voltage regulating devices to control the voltage of the current delivered to the patient's circuit, whatever its modality may be.

By my invention, the slow sinusoidal current produced, has a true sine wave form, and the periodicity or frequency may readily be made from 10 to 12 cycles per minute, or lower if desired, and from that value upwards to 100 cycles per minute, or higher if desired, by simply turning the frequency controlling knob of the machine, maintaining at all times a true sine wave form of delivered current waves, regardless of how rapid or how slow the frequency may be.

In some cases of impaired muscular tone, it is found desirable to vigorously exercise the muscles involved by the application of slow sinusoidal current, and at the same time afford brief intervals of rest between contractions to avoid fatigue. This I provide for in my machine, by furnishing certain of the current modalities selectively delivered, with waves of true sine form and of slow frequency, separated by intervals of no current flow, constituting interrupted slow sinusoidal current modalities.

Again, in other cases of muscular degeneration, it is found to be beneficial to hold the muscular fibres under tension briefly, during each contraction produced by the treatment applied. This I provide for in my machine, by furnishing certain of the current modalities delivered, with waves of true sine form and of slow frequency, each of which waves has a continuing maximum or peak value for an interval equal to that for which the tension on the muscular fibres is to be maintained. These constitute slow sinusoidal sustained peak current modalities.

In producing slow sinusoidal current by my machine, I employ a form of current wave producing mechanism, to which desired current, whether galvanic, alternating, or a combination of the two may be applied, and from which by suitable brushes, current in the form of slow sinusoidal current is delivered, without the use of electro-magnetic induction in any way, means being provided in connection with the wave producing mechanism to impart a desired speed of movement to the brushes, resulting in a corresponding frequency of the slow sinusoidal current. In this way the characteristics of the current applied to the wave producing mechanism, are faithfully preserved and are delivered from the wave producing mechanism with the same characteristics, excepting that the delivered current as a whole has the additional characteristic of having a wave form of slow periodicity, to which slow wave current I prefer to impart a true sine wave form, thus permitting the delivery to a patient's circuit of slow sinusoidal current. This part of my machine affords a convenient means for imparting sinusoidal characteristics to any form of electric current supplied to the wave producing mechanism.

By my invention I provide improved means for interrupting cyclic current flow, whether galvanic, alternating, slow sinusoidal, or a combination of these current modalities, so that a period of no current flow occurs between successive intervals of current flow, by providing in connection with the wave producing mechanism, devices for maintaining the electrical difference of potential between the output conductors of the mechanism, at zero for intervals corresponding to the desired intervals of interruption, without however, conductively opening the circuits involved in delivering the interrupted cyclic current from the wave producing mechanism. In connection with this part of my invention, I may employ in my wave producing mechanism a part having uniform movement which may be selectively operated at different rates as desired corresponding to the periodicity or frequency of the slow wave current to be delivered from the mechanism, and an electric conductor having the current applied to the mechanism, flowing through it and producing in it a drop of electrical potential distributed throughout the length of the conductor, with which conductor the movable part is in contact to engage successively different parts of the conductor producing a cyclic potential difference between the movable part and each end of the conductor, together with devices selectively establishing a zone of constant electrical potential at one end portion of the conductor in the path of travel of the movable part. In this case, the interrupted cyclic action is secured by maintaining the movable part in electrical connection with the part of the conductor having constant potential, without however, interrupting movement of the movable part, for periods corresponding with the desired periods of interruption, and delivering wave current by using the constant potential portion of the conductor and the movable part as the supply terminals of the delivery circuit. In other cases, I may employ two parts movable on the conductor, in which event the interruption in the cyclic action referred to, is effected by maintaining the two movable parts at the same electrical potential without interrupting their movement for periods corresponding with the periods of interruption of the cyclic action, and using the two movable parts as supply terminals of the delivery circuit.

By my invention I further provide devices in connection with the wave producing mechanism, by which the maximum electrical potential applied to a part moving on a conductor as described, and communicated to the output circuit of the mechanism, may be maintained at maximum value for desired intervals corresponding with the peak values of the cyclic action of the mechanism, and that where two movable parts are used to control current flow to the output circuit, the maximum potential between these parts and impressed upon them by the wave producing mechanism, is maintained for a desired period at each peak of the cyclic action of the mechanism, and furthermore that this sustained maximum potential condition upon the output circuit may be secured for any particular current modality supplied to the wave producing mechanism whether galvanic, alternating, slow sinusoidal, or a combination of these modalities, and I designate, for convenience, any current modality having its peak values thus maintained for appreciable intervals as a sustained peak current modality.

More specifically, the wave producing mechanism employed in my machine, may consist of a resistance winding to the terminals of which the current modality may be applied, to which cyclic effect is to be given, the resistance winding being disposed in such a manner that a brush or brushes may rotate over it and be subjected to the potential or potential differences of or between the points of contact with the resistance winding, as the case may be. This, it will be observed, involves no magnetic induction, and yet provides a convenient and simple means for producing cyclic current flow, for example slow sinusoidal current flow, whatever may be the form of the current modality supplied to the resistance winding, as a result of which the delivered sinusoidal current may in addition to being sinusoidal as to its resultant current value, be at the same time galvanic, alternating or a combination of the two. With this construction, interrupted current modalities result from the selective use of devices maintaining the brush or brushes in zones of zero potential or differences of potential for periods corresponding to the periods of cyclic interruption, without however, interrupting the electrical circuits or stopping the rotation of the brushes on the resistance wire, and sustained peak current modalities result from subjecting the brush or brushes to maximum potential for periods corresponding to the periods of maximum voltage of the cyclic current delivered from the wave producing mechanism, without modifying the rotation of the brushes or opening any of the circuit connections.

By my invention I provide a novel switching mechanism in the form of an unitary device having a single operating knob or handle, by which galvanic or alternating current, or a combination of the two may be selectively applied to the wave producing mechanism, and by which the interrupting devices and the sustained peak devices may be selectively connected for operation as desired. The result is that a multiplicity of current modalities may be selectively impressed upon the patient's circuit, by the operation of the single switch knob, depending upon the particular nature of treatment desired.

By my invention I further provide novel means for controlling the rate of operation of the wave producing mechanism, to the end that the cyclic current, for example slow sinusoidal current, whatever the characteristics of its wave may be, may have a desired rate or frequency of operation.

By my invention I also provide as a part of my improved machine, a rheostat, actuated by a suitable controlling knob or handle, for changing as desired the voltage of the particular current modality delivered to the patient's circuit, and in this way I completely control the output of my machine as to current modality selected, the frequency of the slow cyclic or sinusoidal current delivered, and the voltage of the current, by three adjusting knobs.

By my invention I also provide my machine with a pilot lamp connected in a manner to be subjected to the electrical potential available at any time for the patient's circuit, whereby this lamp affords an indication to the operator of whether the machine is in operation, and also affords an indication of the kind of current delivered to the patient's circuit, and of the frequency and nature of the slow sinusoidal current, when that modality in its several aspects, is employed.

In carrying out my invention, I preferably mount the controlling and indicating devices above and on a panel constituting the top of a cabinet, and the apparatus controlled by the controlling devices is preferably mounted from the lower surface of this panel to constitute a self contained structure, which results in the only apparatus above the panel being the controlling and indicating apparatus and in having all of the electrical parts and connections, excepting the binding posts of the patient's circuit, located below the panel where they are protected and concealed from view. In this manner, the moving parts of the apparatus and all of the electrical connections when assembled and made, are in permanent relation to each other and the possibility of proper operative relation between the parts being disturbed, is reduced to a minimum, and furthermore, when inspection of the apparatus is necessary it can be simply effected by raising the panel and placing it in any convenient position or location, which does not disturb the relation of the electrical connections and operating parts, leaving them operative at all times and permitting convenient inspection and repair when necessary.

The above and other objects of my invention will best be understood by reference to the accompanying drawings showing a preferred embodiment thereof, in which

Fig. 1 is a perspective view of the top panel and front of my complete machine,

Fig. 2 is a top view of the panel of my machine, to an enlarged scale,

Fig. 3 is a back view showing the upper part of my machine in elevation, and the stand in vertical, sectional view,

Fig. 4 is a bottom view of a pad heater that may be conveniently used with my machine,

Fig. 5 is a bottom view of the panel shown in Fig. 2, illustrating the mechanism supported by the panel below it,

Fig. 6 is a vertical, sectional view to an enlarged scale, of the parts shown in Fig. 5 taken along the line 6—6,

Fig. 7 is a sectional view of a part of the construction shown in Fig. 6, taken along the line 7—7,

Fig. 8 is a top view of the resistance element of the wave producing mechanism,

Fig. 9 is a sectional view to an enlarged scale of some of the parts shown in Fig. 5, taken along the line 9—9,

Fig. 10 is a sectional view of the parts shown in Fig. 2, taken along the line 10—10,

Fig. 11 is a diagrammatic circuit diagram of the wiring of the machine, and

Figs. 12–27 inclusive are diagrammatic views of the current wave forms of the various current modalities which may be delivered selectively to the patient's circuit by the machine.

Similar numerals refer to similar parts throughout the several views.

As shown in Fig. 1, my machine consists of a panel 10, carrying the controlling and indicating devices above it and supporting the apparatus of the machine below it in a manner to be described, this panel being supported by a stand 11, provided with handle rods 12 and 13 for moving it conveniently from place to place on the castors 14 of the machine. As more clearly shown in Fig. 2, the panel 10 carries a line switch 15 for starting and stopping the machine, a pole changing switch 16 for determining the direction of galvanic current flow through the binding posts 17 and 18 of the patient's circuit which are also supported by the panel, a first knob 19 for operating the current modality switch to supply a desired current modality to the binding posts 17 and 18, a second knob 20 for changing as desired the voltage of the current delivered to the posts 17 and 18, a third knob 21 for changing the frequency of the slow sinusoidal current selectively delivered to the posts 17 and 18, a pilot lamp 22 and a milliammeter 23 for indicating the amount of current flowing in the patient's circuit.

As shown in Fig. 3, the rear wall 24 of a casing supported by the stand 11 and carrying the panel 10, is provided with a first electrical socket 25 for convenient connection with electric wires for supplying the machine with current, for example from the usual lighting circuit, and a second electrical socket 26 of the receptacle type, to receive a plug 27 connected by flexible electrical conductors 28 with an electric heater, for example a pad heating device 29. It will be noted that the handle rods 12 and 13 are substantially parallel with the sides of the stand and that, as shown in Fig. 3, the upper frame members of the stand are metal tubes 11^a, 11^a comprising ledges from which metal sheets 11^b, 11^b extend downwardly to form the side walls of the stand. The heater 29 is provided with downwardly extending short posts or lugs 30 resting against the inner surface of the handle rod 12, for the relation of the parts shown in Fig. 3, and the inner edge of the heater 29, on its lower surface, is provided with lugs 31 projecting sufficiently to extend under the adjacent tube 11ᵃ, nearly or quite into contact with the corresponding metal sheet 11ᵇ, as a result of which the heater 29 is securely supported on the handle rod 12 and with such rigidity that the heater itself may be used to roll the stand and machine from one location to another. The heater may conveniently be provided with an electric switch or switches 32 to control current flow through it. When it is desired to remove the heater from the machine all that is required is to remove the plug 27 from the socket 26 and to raise the outer edge of the heater sufficiently to clear the posts 30 from the handle rod 12 which completely frees the heater from the machine. The heater can be quite as readily placed on the machine by a reverse operation. A second similar heater 29ᵃ is shown supported by the handle rod 13 and in the same manner, to illustrate that a heater of the kind under consideration may readily be supported by the machine on either of its handle rods 12 and 13.

As shown in Fig. 5, the panel 10 carries from its under surface, a motor generator consisting of two units 33 and 34, substantially in alignment with each other and having shafts connected by a coupling device 35 so that rotation of one of the shafts rotates the other of the shafts. One of the shafts, for example the shaft 36 of the unit 34 carries a worm 37 meshing with a worm wheel 38, supported in a manner to be described, by a metal housing 39 supported by the panel 10, to drive the movable parts of the apparatus. The unit 33 of the motor generator is a motor designed to be driven by electric current that may be available. The unit 34 is an electric generator having direct current output conductors 110 and 111ᵃ, which may be respectively positive and negative, and having also alternating current output conductors 111ᵇ and 112. The conductors 111ᵃ and 111ᵇ, as shown, are both connected electrically with conductor 111, which, together with the conductors 110 and 112, constitute the supply conductors extending to the electrical circuits of my machine. The generator 34 is preferably designed to deliver rapidly alternating current, for example of a frequency of 60 cycles per second, or higher, as desired. Since the particular construction of the motor 33 and generator 34, constitutes no part of the present invention, and embodies only structures well known in the art, no particular description of this part of the apparatus is thought to be required.

Besides the parts referred to, the panel 10 carries from its under side, as shown in Fig. 5, a main switch block M and an auxiliary switch block A, co-operating with switches in a manner to be described, to constitute a single switching means for connecting the circuits of the machine to selectively communicate to the patient's circuit, any desired current modality which the machine is capable of delivering. The panel 10 similarly supports a rheostat 40 below which an electrical condenser 151 is mounted in substantially parallel relation. The panel also similarly supports the line switch 15, the pole changing switch 16 and a mounting 22ᵃ for the pilot lamp 22. The particular construction of the switches 15 and 16 and of the pilot lamp and its housing do not constitute a part of my present invention, and as these constructions are well known in the art, it is thought they require no particular description.

The panel 10 also supports from its under surface, bars 42 and 43 of insulating material carrying at their ends, plunger contacts 44 and 45 extending upwardly through a central circular aperture 46 in the panel 10, for a purpose to be described.

As shown in Fig. 6, the housing 39 supports a shaft 47 in suitable bearings, in inclined position to carry the worm wheel 38 so that it meshes with and is driven by the worm 37. The upper face of the worm wheel 38 carries a friction cone 48, the conical surface of which is in contact with the periphery of a friction wheel 49 carried by a hub 50 slidable longitudinally on a shaft 51, supported in suitable bearings by the housing 39, at an angle with the shaft 47 corresponding with the angle of the cone 48, so that as the wheel 49 moves longitudinally on the shaft 51 to secure different speed adjustments of the apparatus, its periphery is at all times in frictional engagement with the surface of the cone 48, to drive the apparatus operated by the shaft 51. The shaft 51 is provided with a keyway 52 engaged by the end of a set screw 53 extending through the hub 50, so that angular motion of the hub 50 and the wheel 49 on the shaft 51 is prevented, but free longitudinal movement of the hub and wheel on the shaft is permitted. The hub 50 is provided with an upper extension 54 engaging one member 55 of a ball bearing, the other member 56 of which is carried by a ring 57. As shown in Fig. 7, the ring 57 carries a screw 58 extending radially therefrom through the end of an adjusting arm 59, which arm is pivotally supported by the housing 39 for rotation around a stud 60, as shown in Fig. 6. The arm 59 is integral with a segmental portion 61 extending upwardly from the pivotal portion of the arm 59, to carry a segmental gear 62 meshing with an idler gear 63, which latter in turn meshes with a gear 64 secured to the lower end of an operating rod 65, supported in a suitable bearing by the housing 39, to extend upwardly through the panel 10. The upper end of the rod 65 carries a tubular and slotted connecting sleeve 66, for receiving the lower end of the rod 67 extending downwardly from the operating knob 21, as shown in Fig. 10. As a result of the construction just described, rotation of the knob 21 moves the arm 59 on its pivot rod 60, and thus moves the friction wheel 49 longitudinally on the shaft 51 to impart different rates of rotation to the shaft 51, assuming that the motor shaft 36 is driven at a uniform speed, which is usually the case.

The shaft 51, as shown in Fig. 6, is extended a short distance above the uppermost position of the ring 57 and rigidly carries an upwardly extending tubular shaft 51^a, coaxial with the shaft 51. The tubular shaft 51^a has mounted upon its upper end, in the opening 46 in the panel 10, oppositely extending radial arms 68 and 69, carrying at their outer ends brushes 70 and 71 of the plunger type which bear against the under surface of a resistance block 72, which block for convenience and to distinguish it from other parts of the apparatus, I call the rotor block. As a result of the construction described, the rotation of the shaft 51 rotates the brushes 70 and 71 on the rotor block, and since the brushes are at the same radial distance from the axis of the shaft, each brush has the same path of travel on the rotor block as the other.

The arms 68 and 69 also carry auxiliary brushes 73 and 74 supported by springs 75 and 76 electrically connecting them with brushes 70 and 71 respectively, which brushes 73 and 74 extend downwardly through the arms 68 and 69, to engage contact segments 77 and 78 carried by the upper surface of the housing 39. It will be understood that all of the brushes 70, 71, 73 and 74, as well as the contact segments 77 and 78, are electrically insulated from the parts carrying them.

The tubular shaft 51^a also carries two collector rings 79 and 80, which are insulated from the shaft and from each other, and have resting upon them plunger brushes 81 and 82 respectively, carried by and insulated from the housing 39. Wires 83 and 84 extend through the tubular shaft 51^a, connecting the brushes 70 and 71 with the collector rings 79 and 80 respectively. The tubular shaft 51^a also carries adjacent the collector rings 79 and 80, an interrupter commutator 85, upon which oppositely disposed brushes 86 and 87 rest. The brushes 86 and 87 are of the plunger type, and are carried by and insulated from the housing 39 and from each other, and comprise a means for interrupting current flow through any circuit connected with these brushes, by periodically opening the circuit. The brushes 81 and 82 comprise a means for impressing upon any desired circuit the electrical potential of either or both of the brushes 70 and 71 as desired.

In Fig. 8, I show the rotor block 72 in top view. This block comprises a flat base 72^a of insulating material, upon which a resistance wire 72^b is closely wound and connected at its ends with terminals 88 and 89. By connecting any desired source of current with the terminals 88 and 89, current will be caused to flow through the rotor winding 72^b, and the drop in voltage through the winding will be determined by the voltage impressed upon it from the source of current, and the resulting current flow through the winding. As a result, when the brushes 70 and 71 are rotated as described, the difference of electrical potential between them for the position shown in Fig. 8 will be zero, since both rest upon the same wire of the winding 72^b, and as the brushes are moved angularly from the position shown, the difference of potential between them increases until when they are in a position at right angles to that shown, the potential difference between them is a maximum, and in this way, by uniformly rotating the brushes, the difference of electrical potential between them may be given a wave form that is a true sine wave, assuming direct current to be flowing through the winding 72^b from a source of electromotive force. It will also be observed, that the difference of electrical potential between either of the brushes 70 and 71, and either of the terminals 88 and 89 of the winding 72^b, will vary from minimum to maximum and then again to minimum, for each rotation of the brushes, and that this variation will have a wave form that is a true sine wave for uniform rotation of the brushes, and direct current flow at constant potential through the winding 72^b. It will be observed however, that the sinusoidal potential difference between the brushes 70 and 71 resulting from their uniform rotation, is alternating in character, for each positive current wave delivered by them, is succeeded by a reversed, or negative current wave, whereas the potential difference between either brush and either winding terminal is unidirectional, and all of the current waves resulting from such potential differences will be sinusoidal and either all positive or all negative, depending upon which terminal of the winding 72^b, is connected with the circuit to which current is delivered. It will be observed that by selecting a path of travel of the brushes 70 and 71, having a diameter equal to the transverse width of the winding 72^b, the maximum potential difference between the brushes 70 and 71 is equal substantially to the voltage drop through the winding 72^b, and that the maximum potential difference between either brush and either terminal of the winding 72^b is substantially equal also to said voltage drop.

The plunger contacts 44 and 45 bear upon the lower surface of the winding 72^b at points substantially equidistant from the ends of the winding, and as a result, when these contacts 44 and 45 are connected respectively with the terminals 88 and 89 of the winding 72^b, the full voltage drop through the winding is absorbed by that part of the winding between the contacts 44 and 45; under such conditions, for rotation of the brushes 70 and 71 as above described, the difference of potential between the brushes 70 and 71, increases until the brushes engage the parts of the winding connected with the contacts 44 and 45, and during the intervals that the brushes are traveling over the parts of the winding that are short circuited by the contacts 44 and 45 when so connected, this maximum difference of potential is maintained and the characteristic above referred to as "sustained peak", results. The segmental contacts 77 and 78 are preferably disposed angularly so that when these contacts are electrically connected with the terminals 88 and 89 respectively, a similar short circuiting of the end portions of the winding 72^b, to that described by connecting the contacts 44 and 45 with the terminals 88 and 89, results and with similar effect. Provision is made for connecting the contacts 44 and 45 and the segmental contacts 77 and 78 as desired, in a manner to be described, so that not only the results already particularly described may be secured, but other desirable results in connection with different modalities of the current desired to be communicated to the patient's circuit.

The relation of one of the plunger contacts 44 and 45, for example the contact 44, to the winding 72^b, is more clearly shown in Fig. 9.

As shown in Fig. 10, the rheostat 40, which is wound with resistance wire 41 and provided with terminals in a manner similar to the rotor block 72 above described, is mounted below the knob 20 and engaged by a contact arm 90, carried by the lower end of an operating rod 92, extending downwardly from the knob 20. A stationary contact clip 93 is provided which is in electrical contact with the arm 90, and any part of the resistance of the wiring of the rotor block may be included in a desired circuit by connecting one terminal of the winding and the contact clip 93 in said circuit.

As indicated in Fig. 10, the main switch block M is provided with four concentric rows of switch contacts, engaged by switch blades 94, 95, 96 and 97, which are carried by a rod 98 extending downwardly from the control knob 19, said switch blades being insulated from each other and from the rod 98. Each of the switch blades 94, 95, 96 and 97 is provided with downwardly extending ends for selectively connecting the contacts of the main switch block M as follows: The switch blade 94 connects a selected contact in the outer row with a contact in the same row that is diametrically opposite to the first contact; the switch blade 95 similarly connects diametrically opposite contacts in the second row; the switch blade 96 similarly connects diametrically opposite contacts in the third row, and the switch blade 97 similarly connects diametrically opposite contacts of the fourth or inner row of contacts. The rod 98 besides supporting the switch blades 94, 95, 96 and 97, also carries below the auxiliary switch block A, oppositely extending metal arms 99 and 100, which are insulated from each other and from the rod 98 and are in the plane of the switch blades 94, 95, 96 and 97. The auxiliary switch block A carries six concentric rows of contacts, the contacts of the outer three rows being respectively and selectively engaged by the plunger contacts 101, 102 and 103 carried by the arm 100, so that any position of the knob 19 bringing the arm 100 in line radially with two or three contacts in the three outer rows of contacts, results in electrically connecting the contacts which are in line with the arm 100 at that time. Similarly, the arm 99 carries three plunger contacts 104, 105 and 106 for selectively engaging respectively the contacts of the three inner rows carried by the auxiliary switch block A, and these plunger contacts electrically connect any of the contacts of the three inner rows that may be in line radially with the arm 99 for any particular adjustment of the knob 19, the plunger contact 101 engaging the outermost row of the contacts and the plunger contact 106 engaging the innermost row of the contacts of the auxiliary switch block.

Current modalities

My machine above described, as illustrating my present invention, provides for delivering to the posts 17 and 18 of the patient's circuit, sixteen different current modalities, that is to say electric currents having sixteen different characteristics, each applicable to a particular treatment of the patient, and for convenience in reference, I refer to these current modalities in terms employed in the electro-therapy, to conveniently identify them and distinguish them from each other.

In Figs. 12–27 inclusive, I illustrate diagrammatically the wave forms of the different current modalities which my machine is adapted to deliver, as illustrative of my invention.

Fig. 12 illustrates galvanic current, which is a current of substantially constant value resulting from the application to the patient's circuit of constant electromotive force.

Fig. 13 illustrates uni-directional galvanic wave current, and comprises a succession of current waves of the same electrical sign and is effected, as will be described, by supplying the terminals of the rotor winding with direct current, and impressing upon the posts 17 and 18 the varying difference of potential between one of the brushes 70 and 71 and a terminal of the rotor winding.

In Fig. 14, slow galvanic sinusoidal current is illustrated, resulting from supplying the winding of the rotor block 72 with direct current, and impressing the potential difference between the brushes 70 and 71 on the posts 17 and 18.

In Fig. 15, alternating sinusoidal wave current is illustrated, resulting from supplying the rotor winding with alternating current, and impressing upon the posts 17 and 18 the potential differences between the brushes 70 and 71. It will be noted that the alternations of current delivered by the generator 34, are present and with the same frequency as found in the alternating current output circuit of the generator, the difference being that the voltage of the successive alternating current waves constituting any one of the sinusoidal waves, varies substantially as indicated for slow galvanic sinusoidal current, excepting that on account of the alternating nature of the current impressed upon the winding of the rotor block, the sinusoidal waves are symmetrical about the reference axis, instead of being alternately positive and negative, as illustrated for the slow galvanic sinusoidal current.

In Fig. 16, superimposed wave current is illustrated resulting from impressing upon the winding of the rotor block 72, a combination of direct and alternating current and impressing upon the posts 17 and 18, the potential difference between the brushes 70 and 71. This effect is similar to slow galvanic sinusoidal current, the difference being that each wave consists of alternations of the same frequency as the frequency of the alternating current generated, the sinusoidal waves resulting from variations in the voltages of the alternations, due to impressing upon the posts 17 and 18, the potential difference between the brushes 70 and 71.

In Fig. 17, alternating sinusoidal interrupted current is illustrated, which is similar to the current modality illustrated in Fig. 15, excepting that between successive groups of alternations, each of which as a whole is sinusoidal in form, a period of interruption occurs, due to connecting together the plunger contacts 44 and 45, as a result of which, for periods corresponding with those during which the brushes 70 and 71 pass over the portion of the winding 72^b between the plunger contacts 44 and 45, no electrical potential is impressed upon the posts 17 and 18.

In Fig. 18, slow sinusoidal interrupted current is illustrated, which is generally similar to the current modality illustrated in Fig. 14, excepting that between successive sinusoidal waves, a period of no current flow exists, due to connecting the plunger contacts 44 and 45 in the manner referred to in connection with the current modality illustrated in Fig. 17, and with the same results.

In Fig. 19, interrupted galvanic wave current is illustrated, which is similar to the current modality illustrated in Fig. 13, excepting that between successive sinusoidal waves. a period of no current flow exists, resulting from connecting one of the plunger contacts 44 and 45, with one of the terminals of the rotor winding, and impressing upon the posts 17 and 18, the potential difference beteween that terminal of the winding and one of the brushes 70 and 71.

In Fig. 20, rapid sinusoidal current is illustrated, which is the result of supplying to the posts 17 and 18, alternating current from the generator 34.

In Fig. 21, interrupted rapid sinusoidal current is illustrated, which is the result of inserting in the circuit used with the current modality illustrated in Fig. 20, the interrupter 85, thus producing in a manner to be described, periods of no current flow between successive periods of rapid sinusoidal current flow.

In Fig. 22, combined galvanic and sinusoidal current is illustrated, due to impressing on the posts 17 and 18 the combined voltage of the alternating current and direct current output conductors of the generator 34, the direct current voltage being substantially equal to the alternating current voltage, as a result of which, the rapid sinusoidal waves are all of the same polarity.

In Fig. 23, interrupted galvanic current is illustrated, resulting from inserting in the circuit used in producing the current modality illustrated in Fig. 12, the interrupter 85, which interrupts the current flow periodically, in a manner to be described.

In Fig. 24, galvanic wave sustained peak current is illustrated, which is similar to the current modality illustrated in Fig. 13, excepting that each current wave is of substantially the same maximum value for an appreciable interval, instead of having an instantaneous peak value, as is the case with the current modality shown in Fig. 13. The current modality illustrated in Fig. 24, results from connecting one of the plunger contacts 44 and 45 and the corresponding segmental contact 77 or 78, with one terminal of the rotor winding, connecting that terminal with one of the direct current output conductors of the generator 34, and impressing upon the posts 17 and 18 the potential difference between one of the brushes 70 and 71 and the other direct current output conductor of the generator. As pointed out above, the connecting of the plunger contact and the segmental contact with the terminal of the rotor winding, impresses a constant electrical potential upon the rotor brush connected in circuit, while it is passing over the short circuited section of the winding of the rotor block, and while the corresponding auxiliary rotor brush is in engagement with the segmental contact. With the circuit connections referred to, this occurs at the time of miximum potential difference between the brush 70 or 71, as the case may be, and the direct current output conductor of the generator, which is directly connected with one of the posts 17 and 18, and thus for an appreciable interval for each wave of the galvanic wave current, the current flow is of constant and maximum amount, as illustrated diagrammatically in Fig. 24.

In Fig. 25, slow galvanic sinusoidal sustained peak current is illustrated, which is similar to the current modality illustrated in Fig. 14, excepting that the current is of constant maximum value for an appreciable interval at the peak of each wave of each sign, instead of having an instantaneous maximum value, as illustrated in Fig. 14. This result is secured by causing direct current flow through the winding of the rotor block, and connecting each terminal of the winding with the adjacent one of the plunger contacts 44 and 45, and with the adjacent one of the segmental contacts 77 and 78, and impressing upon the posts 17 and 18, the potential difference between the rotor brushes 70 and 71. As above described, the maximum potential difference between the brushes 70 and 71, exists at the time when they enter the short circuited end zones of the winding of the rotor block, and this maximum potential difference is maintained during each entire period that the brushes 70 and 71 engage the short circuited end portions of the said winding, during each of which periods, the voltage impressed upon the posts 17 and 18 is substantially constant, the successive waves being positive and negative, as and for the reasons described in connection with Fig. 8 above.

In Fig. 26, alternating sinusoidal sustained peak current is illustrated, which is similar to the current modality illustrated in Fig. 15, excepting that the maximum current value of each group of current alternations is substantially constant for an appreciable interval, instead of having an instantaneous peak value as illustrated in Fig. 15. This result is secured by connecting the plunger contacts and the segmental contacts in the manner described in connection with Fig. 25, and supplying to the winding of the rotor block alternating current instead of direct current, and connecting the brushes 70 and 71 with the posts 17 and 18 in the same manner they are connected for the current modality illustrated in Fig. 25.

In Fig. 27, superimposed wave sustained peak current is illustrated, which is similar to the current modality illustrated in Fig. 16, excepting that the plunger contacts 44 and 45 and the corresponding segmental contacts 77 and 78, are connected with the adjacent terminals of the winding of the rotor block, as described for the current modality illustrated in Fig. 25. This results in each group of current alternations having a constant maximum value for an appreciable interval, instead of an instantaneous peak value, as is the case for the current modality illustrated in Fig. 16. In this case the winding of the rotor block is supplied with current of the kind and in the same manner as described in connection with Fig. 16, with the result that the alternations and waves are sinusoidal in character.

It will be understood that in connection with each of the current modalities illustrated, the rheostat 40 is connected in circuit, so that by operation of the arm 90 by the knob 20, the voltage impressed upon the posts 17 and 18 may be varied as desired from minimum to maximum or vice versa, and that for any of the current modalities illustrated in Figs. 13, 14, 15, 16, 17, 18, 19, 24, 25, 26 and 27, the rapidity or frequency of the relatively slow sinusoidal current waves may be changed as desired through a considerable range, by means of the knob 21. In practice, I find it desirable to rotate the brushes 70 and 71, slowly relatively to the frequency of alternating current found in ordinary house lighting circuits, which is usually sixty cycles per second, so that the slow sinusoidal current delivered by means of the brushes 70 and 71 may have as low a frequency as 10 or 12 cycles per minute up to 100 to 125 cycles per minute as desired. My machine thus affords a means for selectively delivering to the patient's circuit a large number of current modalities, any one of which may have a large number of different impressed voltages, and any one of which resulting from the operation of the brushes 70 and 71, or either of them, may be given many different rates or frequencies of slow sinusoidal action. It will also be noted that for any current modality applied to the posts 17 and 18, where the current flow is uni-directional, the current in the patient's circuit, may be given either direction of flow desired, by means of the pole changing switch 16.

Circuit connections

In Fig. 11, I illustrate diagrammatically the circuit connections of my machine. In this figure, the main switch M and the auxiliary switch A are illustrated diagrammatically with the main switch M in plan view and the auxiliary switch A in bottom view, so that the contacts in each case are above anything that may be supporting them and in position to be engaged by switch blades resting upon them, the direction of progression of the switch blade positions for the auxiliary switch A being reversed, to facilitate visualizing the simultaneous changing from one position to another, of the two switches.

To facilitate tracing the circuit connections, the following system of numbering of the switch contacts is employed. Each radial row of contacts is designated by an Arabic numeral, there being twenty-two of these rows for each switch. Each circular row of contacts is designated by a small letter, the outermost circular row being designated "*a*", the next inner circular row "*b*" etc. For example, the innermost contact for the angular position marked "6" of the main switch M, is designated "M6*d*". Thus the circular rows of contacts for the main switch M, range from *a* to *d* inclusive, and the circular rows of contacts for the switch A, range from *a* to *f* inclusive.

In Fig. 11, the switch blades are not shown, to avoid confusion in tracing the circuit connections. It will be understood that for any numbered position of the switch blades below referred to, the switch blades 94, 95, 96 and 97 are in line with the contacts of switch M of that radial row and electrically connect any contacts in that radial row on which they may then rest, with any contacts respectively in the diametrically opposite radial row on which their opposite ends may rest; also that the arm 100 of the switch A is at the same time in line with the similarly numbered switch blade position of switch A, to electrically connect any of its contacts that may be in that radial row and also in circular rows *a*, *b* and *c*, and that the arm 99 is in line with the diametrically opposite radial row of its contacts to electrically connect any of its contacts in said opposite radial row that may also be in circular rows *d*, *e* and *f*.

In Fig. 11, the supply conductors, corresponding with the output conductors of the generator 34, are shown at 110, 111, 112, the wire 110 being the positive output conductor from the direct current side of the generator, the wire 112 being one output conductor from the alternating current side of the generator, and the wire 111 being a common conductor connected with the other direct current output conductor 111^a, and also with the other alternating current output conductor 111^b.

With the switch blades of the switches M and A in position No. 1, the following circuit connections are made. Wire 110, wire 113, contact M1*b*, contact M12*b*, wire 115, choke coil 114, wire 130, wire 116, rheostat winding 41, wire 117, wire 118, contact M22*c*, wire 135, contact A1*a*, contact A1*b*, wire 138, wire 143, contact M12*c*, contact M1*c*, wire 119 to wire 111. This impresses direct current from wires 110 and 111 upon the rheostat winding 41. Wire 117 is connected by wire 120 with the pole changing switch 116 and the rheostat arm 90 is connected by wire 121 with the other supply terminal of the pole changing switch 16. One output terminal of the pole changing switch 16 is connected by wire 122 with the post 17 and the other terminal of said switch is connected by wire 123 with milliammeter 23, the other terminal of which is connected with the post 18. The condenser 151 is at this time connected with the wires 122 and 123 through wire 148, contact M12*a*, contact M1*a*, wire 147 and wire 149, to cooperate with the choke coil 114, in smoothing out any slight ripples that might otherwise be present in the direct current flow. As a result of these connections, direct or galvanic current as illustrated in Fig. 12, is delivered to the posts 17 and 18, and thus to the patient's circuit.

When the switch blades are moved to position No. 2 the following circuit connections are made. Wire 110, wire 113, contact M2*a*, contact M13*a*, wire 124, wire 125, terminal 88, rotor winding 72^b, terminal 89, wire 127, wire 128, contact M13*b*, contact M2*b*, wire 119, to wire 111. This causes direct current flow through the rotor winding 72^b resulting in a voltage drop through said winding substantially equal to the voltage of the generator. At the same time the following connections are made. Rotor brush 71, to collector ring 80, brush 82, wire 126, contact M2*d*, contact M13*d*, wire 116, rheostat winding 41, wire 117, wire 118, contact M13*c*, contact M2*c*, wire 119 to wire 111. It will be noted that the condenser 151 is not used in this case, and that the circuit connections between the rheostat winding 41 and the posts 17 and 18 remain the same at all times, and that therefore it is unnecessary to trace this part of the circuit in each case. The circuits just traced result in impressing on the terminals of the rheostat winding 41 unidirectional galvanic wave current, as a result of which the current modality illustrated in Fig. 13, is delivered from posts 17 and 18 to the patient's circuit.

When the switch blades are moved to position No. 3, the following circuit connections are made. Wire 110, wire 113, contact M3*a*, contact M14*a*, wire 124, wire 125, terminal 88, rotor winding 72^b, terminal 89, wire 127, wire 128, contact M14*b*, contact M3*b*, wire 119, to wire 111, thus causing galvanic current to flow through the rotor winding 72^b. In addition, the following circuit connections are made. Rotor brush 70, collector ring 79, brush 81, wire 129, contact M3*c*, contact M14*c*, wire 118, wire 117, rheostat winding 41, wire 116, contact M14*d*, contact M3*d*, wire 126, brush 82, collector ring 80, rotor brush 71. The circuit just traced results in supplying slow galvanic sinusoidal current illustrated in Fig. 14, to the rheostat winding 41 and thus to the posts 17 and 18.

When the switch blades are moved to position No. 4, the following circuit connections are made. Wire 111, wire 119, contact M4*a*, contact M15*a*, wire 124, wire 125, terminal 88, rotor winding 72^b, terminal 89, wire 127, wire 128, contact M15*b*, contact M4*b*, to wire 112. This causes alternating current flow through the rotor winding 72^b. In addition, the following circuit connections are made. Rotor brush 70, collector ring 79, brush 81, wire 129, contact M4*c*, contact M15*c*, wire 118, wire 117, rheostat winding 41, wire 116, contact M15*d*, contact M4*d*, wire 126, brush 82, collector ring 80, to rotor brush 71. The circuits just traced communicate the alternations of the alternating current flowing through the rotor winding 72^b to the posts 17 and 18 with sinusoidally varying voltages determined by the rotation of the rotor brushes 70 and 71 in the manner above described, resulting in alternating sinusoidal wave current, illustrated in Fig. 15, being supplied to the patient's circuit.

When the switch blades are moved to position No. 5, the following circuit connections are made. Wire 110, wire 113, contact M5*a*, contact M16*a*, wire 124, wire 125, terminal 88, rotor winding 72^b, terminal 89, wire 127, wire 128, contact M16*b*, contact M5*b*, to wire 112. This supplies a combination of direct or galvanic current and alternating current to the rotor winding 72^b. In addition the following circuit connections are made. Rotor brush 71, collector ring 80, brush 82, wire 126, contact M5*d*, contact M16*d*, wire 116, rheostat winding 41, wire 117, wire 118, contact M16*c*, contact M5*c*, wire 129, brush 81, collector ring 79, to rotor brush 70. This connects the rheostat winding 41 with the rotor brushes 70 and 71, as a result of which superimposed wave current, illustrated in Fig. 16, is supplied to the posts 17 and 18, and to the patient's circuit.

When the switch blades are moved to position No. 6, the following circuit connections are made. Wire 112, contact M6*b*, contact M17*b*, wire 128, wire 127, terminal 89, rotor winding 72^b, terminal 88, wire 125, contact A17*d*, contact A17*e*, wire 131, contact M17*a*, contact M6*a*, wire 119, to wire 111. In addition, the following circuit connections are made. Plunger contact 44, wire 132, wire 133, contact A6*a*, contact A6*b*, wire 134 to plunger contact 45. The connections last traced short circuit that part of the rotor winding 72^b between the plunger contacts 44 and 45. In addition, the following circuit connections are made. Rotor brush 70, collector ring 79, brush 81, wire 129, contact M6*c* contact M17*c*, wire 118, wire 117, rheostat winding 41, wire 116, contact M17*d*, contact M6*d*, wire 126, brush 82, collector ring 80, rotor brush 71. The circuits just traced result in impressing upon the rheostat winding 41, and upon the posts 17 and 18, alternating sinusoidal interrupted current illustrated in Fig. 17, the short circuiting of the mid section of the rotor winding 72^b causing an interruption in current flow between successive waves or groups of alternations, and thus producing the current modality illustrated diagrammatically in Fig. 17.

When the switch blades are moved to position No. 7, the following circuit connections are made. Wire 110, wire 113, contact M7*a*, contact M18*a*, wire 124, wire 125, terminal 88, rotor winding 72^b, terminal 89, wire 127, wire 128, contact M18*b*, contact M7*b*, wire 119, to wire 111. In addition to these connections, the mid-section of the rotor winding 72^b is short circuited as follows: plunger contact 44, wire 132, wire 133, contact A7*a*, contact A7*b*, wire 134 to plunger contact 45. At the same time the rotor brushes are connected as follows. Rotor brush 70, collector ring 79, brush 81, wire 129, contact M7*c*, contact M18*c*, wire 118, wire 117, rheostat winding 41, wire 116, contact M18*d*, contact M7*d*, wire 126, brush 82, collector ring 80, to rotor brush 71. This supplies galvanic current to the rotor winding 72^b, and the rotor brushes 70 and 71 cause slow galvanic sinusoidal current to flow from the posts 17 and 18 in a manner similar to that described for the current modality shown in Fig. 14, the difference being that for the period during which the rotor brushes 70 and 71 pass over the now short circuited midportion of the rotor winding 72^b, there is no electrical potential difference between them and an interruption in current flow results between each pair of slow sinusoidal waves of current delivered from the posts 17 and 18, producing in the patient's circuit slow sinusoidal interrupted current illustrated in Fig. 18.

When the switch blades are moved to position No. 8, the following circuit connections are made. Wire 110, wire 113, contact M8*a*, contact M19*a*, wire 124, wire 125, terminal 88, rotor winding 72^b, terminal 89, wire 127, wire 128, contact M19*b*, contact M8*b*, wire 119, to wire 111. In addition, the following circuit connections are made. Rotor brush 71, collector ring 80, brush 82, wire 126, contact M8*d*, contact M19*d*, wire 116, rheostat winding 41, wire 117, wire 118, contact M19*c*, wire 135, contact A1*a*, wire 136, contact A8*b*, and thence in two paths as follows: first, to contact A8*a*, wire 140, to wire 111, and second, to contact A8*c*, wire 134, to plunger contact 45. As a result one end portion of the rotor winding 72^b is short circuited, and this end is connected with the rheostat winding 41. Thus galvanic current is caused to flow through the remaining portion of said winding, and the electrical potential difference between the supply conductor connected with the short circuited portion of said rotor winding and one of the rotor brushes is impressed upon the rheostat winding 41, and a desired part of it, depending upon the setting of the rheostat arm 90, is impressed upon the posts 17 and 18. Furthermore, when the rotor brush passes over the short circuited end portion of the rotor winding said potential difference is zero and current flow in the patient's circuit connected with the posts 17 and 18 is interrupted, and the current modality supplied to the patient's circuit is interrupted galvanic wave current illustrated in Fig. 19.

When the switch blades are moved to position No. 9, the following circuit connections are made. Wire 112, contact M9*d*, contact M20*d*, wire 116, rheostat winding 41, wire 117, wire 118, contact M20*c*, contact M9*c*, wire 119, to wire 111. This causes alternating or rapid sinusoidal current to flow through the rheostat winding 41, and such a part of its voltage to be communicated to the posts 17 and 18 as may be determined by the position of the arm 90 on the rheostat winding, and as a result rapid sinusoidal current illustrated in Fig. 20, is caused to flow in the patient's circuit. In this case I illustrate the manner in which the ammeter 23 in the patient's circuit may be shunted, where, as in this case, the current flow through it is of a kind to which the ammeter, if of the direct current type, cannot respond. As shown, the terminals of the ammeter are connected by wires 150 and 149 with contacts M9*a* and M20*a* respectively, and since said contacts are now connected by switch blade 94, a low resistance conductive path for current flow is provided around the ammeter, which prevents current flow to an appreciable extent through the ammeter. Obviously, any available contacts for any of the switch blade positions, that can be connected by any one of the switch blades in that position, may be similarly employed, if desired.

When the switch blades are moved to position No. 10, the following circuit connections are made. Wire 112, contact M10*d*, contact M21*d*, wire 116, rheostat winding 41, wire 117, brush 87, rotary interrupter 85, brush 86, wire 137, wire 138, wire 139, contact A10*b*, contact A10*a*, wire 140, to wire 111. This has the same effect as above discussed resulting in the current modality illustrated in Fig. 20, excepting that the supply circuit to the rheostat winding 41 is periodically opened, depending upon the rate of rotation of the interrupter 85, thus producing interrupted rapid sinusoidal current, illustrated in Fig. 21. It will be noted that the interrupter 85 comprises two conducting segments 85^a and 85^b, the segment 85^a being greater than a half circle in angular extent, and the segment 85^b being correspondingly less than a half circle in angular extent, and insulated from the segment 85^a. As a result of the brushes 86 and 87 being diametrically opposite each other, as above described, they cannot both engage the segment 85^b at the same time, and the circuit controlled by the interrupter 85, is closed during the periods when both of the brushes engage the segment 85^a, and is opened by the interrupter during the periods when either of the brushes engages only the segment 85^b. In this case, the ammeter 23 is shunted by wires 150 and 149 extending from its terminals to contacts M10*a* and M21*a* respectively, which contacts are now connected by switch blade 94, closing a low resistance conductive path around the ammeter.

When the switch blades are moved to position No. 11, the following circuit connections are made. Wire 110, wire 141, contact A11*b*, contact A11*a*, wire 142, contact M11*d*, contact M22*d*, wire 116, rheostat winding 41, wire 117, wire 118, contact M22*c*, contact M11*c*, to wire 112. In this manner a combination of galvanic and alternating or rapid sinusoidal current is supplied to the rheostat winding 41, and combined galvanic and sinusoidal current illustrated in Fig. 22, is delivered to the posts 17 and 18 at a voltage determined by the position of the arm 90 on the rheostat winding 41.

When the switch blades are moved to position No. 12, the following circuit connections are made. Wire 110, wire 113, contact M1*b*, contact M12*b*, wire 115, choke coil 114, wire 130, wire 116, rheostat winding 41, wire 117, brush 87, interrupter 85, brush 86, wire 137, wire 143, contact M12*c*, contact M1*c*, wire 119, to wire 111. In this manner galvanic current is caused to flow through the rheostat winding 41 in the same manner described for the current modality shown in Fig. 12, excepting that in this case the interrupter 85 is included in the circuit and periodically opens and closes the circuit, depending upon the rate of rotation of the interrupter. A desired part of the voltage upon the current flowing through the rheostat winding 41, is impressed upon the posts 17 and 18 to produce in the patient's circuit, interrupted galvanic current illustrated in Fig. 23. In this case the condenser 151 is connected with the wires 122 and 123 in the same manner and for a purpose similar to that described above in connection with position No. 1 of the switch blades. It will be noticed that with this current modality, the current flow is substantially constant and maximum throughout the entire duration of each period of current flow, instead of gradually increasing to its maximum value and then gradually decreasing to zero, as is the case for the interrupted galvanic wave current illustrated in Fig. 19.

When the switch blades are moved to position No. 13, the following circuit connections are made. Wire 110, wire 113, contact M2*a*, contact M13*a*, wire 124, wire 125, terminal 88, rotor winding 72^b, terminal 89, wire 127, wire 128, contact M13*b*, contact M2*b*, wire 119, to wire 111. In addition the end of the rotor winding connected with wire 110 as described, is also connected with the adjacent plunger contact and segmental contact as follows: wire 125, contact A13a to contacts A13b and A13c and from said contacts respectively by wires 144 and 132 to segmental contact 77 and plunger contact 44. At the same time, one of the rotor brushes is connected as follows: wire 111, wire 119, contact M2c, contact M13c, wire 118, wire 117, rheostat winding 41, wire 116, contact M13d, contact M2d, wire 126, brush 82, collector ring 80, to rotor brush 71. The connection described result in producing current flow from the posts 17 and 18 in the patient's circuit, similar to the current modality illustrated in Fig. 13, the difference being due to now short-circuiting one end portion of the rotor winding 72b. The connection of the plunger contact 44 with the terminal 88 of the rotor winding 72b, short-circuits that end portion of the winding, but if alone depended upon, would not result in a uniform electrical potential on the rotor brush 71 when it travels over the short-circuited end portion of the winding, due to a slight difference in resistance between the rotor brush and the short-circuiting connection as the brush passes over the wire of the short-circuited portion of the winding. To avoid this departure from a uniformly maximum value of the current wave throughout each period of travel of the brush over the short-circuited portion of the rotor winding, at the same time the rotor brush 71 enters the short circuited zone of the rotor winding 72b, the auxiliary brush 74 engages the segmental contact 77 and remains in engagement therewith until the rotor brush 71 leaves the short-circuited zone, thus providing a path of low resistance between the brush 71 and the terminal 88 and maintaining maximum electrical potential on the brush 71 during each entire period of its travel across the short-circuited zone of the rotor winding 72^b. This results in supplying to the posts 17 and 18, galvanic wave sustained peak current illustrated in Fig. 24.

When the switch blades are moved to position No. 14, the following circuit connections are made. Wire 110, wire 113, contact M3a, contact M14a, wire 124, wire 125, terminal 88, rotor winding 72b, terminal 89, wire 127, wire 128, contact M14b, contact M3b, wire 119, to wire 111. This connects the rotor winding 72b with the supply wires 110 and 111 in the same manner described above for position No. 3 of the switch blades. In addition, connection is made between wire 125 and contacts A14a, A14b and A14c, and between the latter two contacts and segmental contact 77 and plunger contact 44 respectively by wires 144 and 132. This establishes the same short circuited condition of the end portion of the rotor winding 72b, adjacent the terminal 88, as described for position No. 13 of the switch blades. At the same time, connection is made between wire 127, segmental contact 78 and plunger contact 45, as follows: wire 127, wire 146, contact A3f to contacts A3e and A3d, and from the latter contacts by wires 145 and 134 respectively to segmental contact 78 and plunger contact 45. This short circuits the end portion of the rotor winding 72b adjacent the terminal 89 in the same manner and with the same results described for the now short circuited condition of the end portion of the rotor winding 72b adjacent the terminal 88. At the same time, the rotor brushes 70 and 71 are connected as follows: rotor brush 70, collector ring 79, brush 81, wire 129, contact M3c, contact M14c, wire 118, wire 117, rheostat winding 41, wire 116, contact M14d, contact M3d, wire 126, brush 82, collector ring 80, to rotor brush 71. This connects the rotor brushes with the rheostat winding 41 in the same manner described above for position No. 3 of the switch blades, but with the difference that the maximum current value through the winding 41, is maintained during each period that the rotor brushes 70 and 71 engage the short-circuited zones of the rotor winding 72b. It is to be noted that the relation of the auxiliary brush 74 to the rotor brush 71 is substantially the same as the relation already described, of the auxiliary brush 73 to the rotor brush 70, as a result of which the auxiliary brushes 73 and 74 successively and alternately engage the segmental contacts 77 and 78; it is further to be noted that for each entire period that either of the rotor brushes 70 and 71 is in either of the short-circuited zones of the rotor winding 72b, the other of said brushes is in the other of said short-circuited zones. As a result, slow galvanic sinusoidal sustained peak current illustrated in Fig. 25, is supplied to the patient's circuit connected with the posts 17 and 18.

When the switch blades are moved to position No. 15, the following circuit connections are made. Wire 111, wire 119, contact M4a, contact M15a, wire 124, wire 125, terminal 88, rotor winding 72^b, terminal 89, wire 127, wire 128, contact M15b, contact M4b, to wire 112. This supplies alternating current to the rotor winding 72^b in the same manner described above for the production of alternating sinusoidal wave current, illustrated in Fig. 15. At the same time the following circuit connections are made. Rotor brush 70, collector ring 79, brush 81, wire 129, contact M4c, contact M15c, wire 118, wire 117, rheostat winding 41, wire 116, contact M15d, contact M4d, wire 126, brush 82, collector ring 80, to rotor brush 71. This connects the rotor brushes 70 and 71 with the rheostat winding 41 in the same manner described above for the current modality illustrated in Fig. 15. At the same time, the following circuit connections are made: wire 125, contact A15a to contacts A15*b* and A15*c* and from the latter contacts by wires 144 and 132 respectively to segmental contact 77 and plunger contact 44; also, from wire 127, wire 146, contact A4*f* to contacts A4*e* and A4*d* and from the latter contacts, by wires 145 and 134 respectively, to segmental contact 78 and plunger contact 45. Thus the terminals 88 and 89 are connected with the segmental contacts 77 and 78 and with the plunger contacts 44 and 45 in the same manner described for the production of slow galvanic sinusoidal sustained peak current illustrated in Fig. 25, the difference in the present case being that alternating current is now supplied to the rotor winding 72^b, and as a result, alternating sinusoidal sustained peak current illustrated in Fig. 26, is delivered from the posts 17 and 18 to the patient's circuit.

With the switch blades moved to position No. 16, the following circuit connections are made. Wire 110, wire 113, contact M5*a*, contact M16*a*, wire 124, wire 125, terminal 88, rotor winding 72^b, terminal 89, wire 127, wire 128, contact M16*b*, contact M5*b*, to wire 112. This causes combined galvanic and alternating current to flow through the rotor winding 72^b in the same manner described above for the production of superimposed wave current illustrated in Fig. 16. At the same time, circuit connections are made as follows: rotor brush 71, collector ring 80, brush 82, wire 126, contact M5*d*, contact M16*d*, wire 116, rheostat winding 41, wire 117, wire 118, contact M16*e*, contact M5*e*, wire 129, brush 81, collector ring 79, to rotor brush 70. This connects the rotor brushes 70 and 71 in the same manner described above for the current modality illustrated in Fig. 16. At the same time the following circuit connections are made: wire 125, contact A16*a*, to contacts A16*b* and A16*c* connected by wires 144 and 132 respectively with segmental contact 77 and plunger contact 44; also wire 127, wire 146, contact A5*f* to contacts A5*e* and A5*d* connected by wires 145 and 134 with segmental contact 78 and plunger contact 45. This short circuits the end portions of the rotor winding 72^b in the same manner described in connection with the production of slow galvanic sinusoidal sustained peak current illustrated in Fig. 25, the difference being that in the present case, by supplying combined galvanic and alternating current to the rotor winding 72^b, superimposed wave sustained peak current illustrated in Fig. 27, is delivered from the posts 17 and 18 to the patient's circuit.

From the above, it will appear that my improved wave producing mechanism has important characteristics as follows: first, the rotor winding provides a plurality of electrical contact points of progressingly different electrical potential, whereby a brush resting upon one of said contact points is given the same electrical potential to cause current flow in a circuit of which the brush may be a part; second, two series of such contact points are provided, in circular arrangement with points of maximum difference of electrical potential at opposite points of the circle; third, the rotation of one or more brushes on said contact points produces a wave of electromotive force between one of the brushes and one of said contact points or between said brushes as the case may be; fourth, by uniformly distributing among said contact points the maximum difference of electrical potential, and equally spacing said contact points in a linear direction, and by uniformly rotating said brushes, an electromotive force of true sine wave form is impressed upon the brush or brushes; fifth, with the contact points stationary, it impresses one cycle of electromotive force on the brush or brushes, as the case may be, for each rotation of the brushes, resulting in no greater relative movement between the contact points and the brushes, than the frequency of the slow sinusoidal electromotive force impressed upon the brush or brushes, which is equal to their rate of rotation, insuring accurate and reliable contact between the brushes and the contact points; sixth, it impresses upon the brush or brushes, a resultant electromotive force of slow sinusoidal wave form, whether the electromotive force distributed among the contact points be direct, alternating and of whatever frequency it may be, or of any other form; seventh, by extending a conductor or conductors from a contact point or points of intermediate electrical potential, and connecting the conductor or conductors with the end contact point or points of the series, or by connecting the conductors with each other, the distribution of electrical potential between the contact points is shifted in different ways, permitting the impressing on the output circuit of (*a*) uni-directional slow wave electromotive force with sustained peak, (*b*) uni-directional interrupted slow wave electromotive force, (*c*) slow sinusoidal electromotive force with sustained peak, and (*d*) interrupted sinusoidal electromotive force, the particular nature of each electromotive force so impressed, depending upon the nature of the electromotive force distributed among the contact points. Furthermore, all of these conditions may be produced with the brush or brushes rotating at the same uniform rate, and for any of these conditions, the rate of rotation of the brush or brushes may be instantly changed through a considerable range without stopping the machine, or changing any of its parts; eighth, by the use of contact segment or segments and the auxiliary brush or brushes, and connections selectively made between the segment or segments and the end one or ones of the series of contact points, the short-circuited end zones of the contact points are positively maintained at constant electrical potential throughout the said zones, producing sustained peak waves having peak values that are constant.

While I have shown my invention in the particular embodiment above described, it will be understood that I do not limit myself to this exact construction as I may employ equivalents known to the art at the time of the filing of this application without departing from the scope of the appended claims.

What I claim is:

1. In an electro-therapeutic machine, the combination of a flat block of insulating material, a resistance winding having its turns extending in parallel relation across the flat surface of said block, a brush mounted for rotation upon and laterally of the turns of said winding on said flat surface, means imparting continuous operation to said brush, and devices for selectively maintaining certain turns of said winding within the path of travel of said brush at substantially the same electrical potential.

2. In an electro-therapeutic machine, the combination of a flat block of insulating material, a resistance winding having its turns extending in parallel relation across the flat surface of said block, brushes mounted for rotation upon and laterally of the turns of said winding on said flat surface, means imparting continuous operation to said brushes, and devices for selectively maintaining certain turns of said winding within the paths of travel of said brushes at substantially the same electrical potential.

3. In an electro-therapeutic machine, the combination of a flat block of insulating material, a resistance winding having its turns extending in parallel relation across the flat surface of said block, brushes mounted for rotation upon and laterally of the turns of said winding on said flat surface, means imparting continuous operation to said brushes, and devices for selectively maintaining certain turns of said winding within the paths of travel of said brushes at substantially the same electrical potential, the paths of travel of said brushes on said winding being substantially coincident.

4. In an electro-therapeutic machine, the combination of a flat block of insulating material, a resistance winding having its turns extending in parallel relation across the flat surface of said block, a brush mounted for rotation upon and laterally of the turns of said winding on said flat surface, means imparting continuous operation to said brush, and switching mechanism for selectively short-circuiting certain turns of said winding within the path of travel of said brush.

5. In an electro-therapeutic machine, the combination of a flat block of insulating material, a resistance winding having its turns extending in parallel relation across the flat surface of said block, brushes mounted for rotation upon and laterally of the turns of said winding on said flat surface, means imparting continuous operation to said brushes, and switching mechanism for selectively short-circuiting certain turns of said winding within the paths of travel of said brushes.

6. In an electro-therapeutic machine, the combination of a flat block of insulating material, a resistance winding having its turns extending in parallel relation across the flat surface of said block, brushes mounted for rotation upon and laterally of the turns of said winding on said flat surface, means imparting continuous operation to said brushes, and switching mechanism for selectively short-circuiting certain turns of said winding within the paths of travel of said brushes, the paths of travel of said brushes on said winding being substantially coincident.

7. In an electro-therapeutic machine, means for delivering wave current of low frequency with interruptions between successive waves, comprising the combination of a flat resistance winding for receiving current from a desired source, a brush mounted for rotation upon a flat side of the turns of said winding, means imparting continuous operation to said brush, electrical connections for selectively short-circuiting turns of said winding adjacent one of its ends and extending into the path of travel of said brush, and delivery circuit connections extending from said brush and from the short-circuited end of said winding, whereby for each passage of said brush over said short-circuited turns there is a corresponding interruption in current flow in the delivery circuit.

8. In an electro-therapeutic machine, means for delivering wave current of low frequency with interruptions between successive waves, comprising the combination of a flat resistance winding for receiving current from a desired source, brushes mounted for rotation upon a flat side of the turns of said winding, means imparting continuous operation to said brushes, electrical connections for selectively short-circuiting turns of said winding at its mid portion in the paths of travel of said brushes, and delivery circuit connections extending from said brushes, whereby for each passage of said brushes over said short-circuited turns there is a corresponding interruption in current flow in the delivery circuit.

9. In an electro-therapeutic machine, means for delivering wave current of low frequency with sustained peak voltage for each wave, comprising the combination of a flat resistance winding for receiving current from a desired source, a brush mounted for rotation upon a flat side of the turns of said winding, means imparting continuous oper-

ation to said brush, electrical connections for selectively short-circuiting turns of said winding adjacent one of its ends and extending into the path of travel of said brush, and delivery circuit connections extending from said brush and from the end of said winding remote from its short-circuited end, whereby for each passage of said brush over said short-circuited turns maximum voltage is sustained on said delivery circuit for a corresponding interval.

10. In an electro-therapeutic machine, means for delivering wave current of low frequency with sustained peak voltage for each wave, comprising the combination of a flat resistance winding for receiving current from a desired source, brushes mounted for rotation upon a flat side of the turns of said winding, means imparting continuous operation to said brushes, electrical connections for selectively short-circuiting turns of said winding adjacent each of its ends and extending into the path of travel of said brushes, and delivery circuit connections extending from said brushes, whereby for each passage of said brushes over said short-circuited turns maximum voltage is sustained on said delivery circuits for a corresponding interval.

11. In an electro-therapeutic machine, an electromotive force controller comprising the combination of a resistance winding for current flow resulting from an applied electromotive force, devices for selectively maintaining certain turns of said resistance winding at substantially the same electrical potential, a brush having cyclic movement upon and laterally of said resistance winding including said certain turns thereof for either electrical condition of said certain turns, and means imparting continuous operation to said brush, whereby cyclic electromotive forces of different characteristics may be selectively applied to a circuit including said brush.

12. In an electro-therapeutic machine, an electromotive force controller comprising the combination of a resistance winding for current flow resulting from an applied electromotive force, devices for selectively maintaining certain turns of said resistance winding at substantially the same electrical potential, brushes having cyclic movement upon and laterally of said resistance winding including said certain turns thereof for either electrical condition of said certain turns, and means imparting continuous operation to said brushes, whereby cyclic electromotive forces of different characteristics may be selectively applied to a circuit including said brushes.

13. In an electro-therapeutic machine, an electromotive force controller comprising the combination of a resistance winding for current flow resulting from an applied electromotive force, devices for selectively maintaining certain turns of said resistance winding at substantially the same electrical potential, a brush having cyclic movement upon and laterally of said resistance winding including said certain turns thereof for either electrical condition of said certain turns, means imparting continuous operation to said brush, whereby cyclic electromotive forces of different characteristics may be selectively applied to a circuit including said brush, and second devices for changing as desired the movement of said brush relatively to said resistance winding.

14. In an electro-therapeutic machine, an electromotive force controller comprising the combination of a resistance winding for current flow resulting from an applied electromotive force, devices for selectively maintaining certain turns of said resistance winding at substantially the same electrical potential, brushes having cyclic movement upon and laterally of said resistance winding including said certain turns thereof for either electrical condition of said certain turns, means imparting continuous operation to said brushes, whereby cyclic electromotive forces of different characteristics may be selectively applied to a circuit including said brushes, and second devices for changing as desired the movement of said brushes relatively to said resistance winding.

15. In an electro-therapeutic machine, mechanism for controlling electromotive force comprising the combination of a series of electrical contacts, electrical connections between a source of electromotive force and said contacts distributing said electromotive force among said contacts, brush mechanism having cyclic movement on said contacts, means imparting continuous operation to said brush mechanism, terminals for supplying current to an output circuit, and mechanism for selectively impressing upon said terminals through said brush mechanism electromotive forces having different wave forms for the same cyclic movement of said brush mechanism on said contact points.

16. In an electro-therapeutic machine, mechanism for controlling electromotive force comprising the combination of a series of electrical contacts, electrical connections between a source of electromotive force and said contacts distributing said electromotive force among said contacts, devices for shifting when desired the distribution of said electromotive force among said contacts, and means imparting continuous operation to said brushes, and brushes having the same cyclic movement on said contacts for either of said conditions of electromotive force distribution, whereby cyclic electromotive forces of different characteristics may be selectively applied to a circuit including said brushes.

17. In an electro-therapeutic machine,

mechanism for controlling electromotive force comprising the combination of a series of stationary electrical contacts, electrical connections between a source of electromotive force and said contacts distributing said electromotive force among said contacts, devices for shifting when desired the distribution of said electromotive force among said contacts, a brush having the same cyclic movement on said contacts for either of said conditions of electromotive force distribution, and means imparting continuous operation to said brush, whereby cyclic electromotive forces of different characteristics may be selectively applied to a circuit including said brush.

18. In an electro-therapeutic machine, mechanism for controlling electromotive force comprising the combination of a series of electrical contacts, electrical connections between a source of electromotive force and said contacts distributing said electromotive force among said contacts, devices for shifting when desired the distribution of said electromotive force among said contacts, a brush having the same cyclic movement on said contacts for either of said conditions of electromotive force distribution, means imparting continuous operation to said brush, whereby cyclic electromotive forces of different characteristics may be selectively applied to a circuit including said brush, and second devices for changing as desired the movement of said brush relatively to said contacts.

19. In an electro-therapeutic machine, mechanism for controlling electromotive force comprising the combination of a series of electrical contacts, electrical connections between a source of electromotive force and said contacts distributing said electromotive force among said contacts, devices for shifting when desired the distribution of said electromotive force among said contacts, brushes having the same cyclic movement on said contacts for either of said conditions of electromotive force distribution, means imparting continuous operation to said brushes, whereby cyclic electromotive forces of different characteristics may be selectively applied to a circuit including said brushes, and second devices for changing as desired the movement of said brushes relatively to said contacts.

20. In an electro-therapeutic machine, mechanism for controlling electromotive force comprising the combination of a series of electrical contacts, electrical connections between a source of electromotive force and said contacts distributing said electromotive force among said contacts, devices for shifting when desired the distribution of said electromotive force among said contacts, a brush having the same cyclic movement on said contacts for either of said conditions of electromotive force distribution, and means imparting continuous operation to said brush, whereby cyclic electromotive forces of different characteristics may be selectively applied to a circuit including said brush, the distribution of said electromotive force and the movement of said brush cooperating to impress on said brush an electromotive force wave of sine form.

21. In an electro-therapeutic machine, the combination of a series of electrical contacts, connections between said contacts and a source of electromotive force applying said electromotive force progressively by successive increments to said contacts, brush mechanism for connection with an output circuit and movable cyclically over said contacts, means imparting continuous operation to said brush mechanism, and devices selectively impressing said electromotive in different wave forms upon said brush mechanism for the same cyclic movement of the latter.

22. In an electro-therapeutic machine, the combination of a resistance element having contact points, a first brush mounted for cyclic movement on said contact points, a second brush having similar cyclic movement, means imparting continuous operation to said brushes and a contact segment engaging said second brush for part of each cycle of motion of said brushes.

23. In an electro-therapeutic machine, the combination of a resistance element having contact points in circular arrangement, a pair of brushes mounted for rotation on said contact points, means imparting continuous operation to said brushes, a contact segment, and an additional brush engaging said contact segment for part of each rotation of said brushes.

24. In an electro-therapeutic machine, the combination of a flat sided resistance winding, a first brush mounted for rotation on said winding, a second brush mounted for rotation with said first brush, means imparting continuous operation to said brushes, and a contact segment engaging said second brush for part of each rotation of said brushes.

25. In an electro-therapeutic machine, the combination of a flat sided resistance winding, a brush mounted for movement in a circular path on said winding, means imparting continuous operation to said brush, a conductor extending from a turn of said winding crossing said path at two points, and switching means for selectively connecting and disconnecting said conductor and a terminal of said winding with and from each other respectively.

26. In an electro-therapeutic machine, the combination of a flat sided resistance winding, two brushes mounted for movement in substantially the same circular path on said winding and oppositely disposed in said path, means imparting continuous operation to said brushes, two conductors extending

from two turns of said winding separated from each other and each crossing said path at two points, and switching means for selectively connecting and disconnecting said conductors with and from each other respectively.

27. In an electro-therapeutic machine, the combination of a flat sided resistance winding, two brushes mounted for movement in substantially the same circular path on said winding and oppositely disposed in said path, means imparting continuous operation to said brushes, two conductors extending from two turns of said winding separated from each other and each crossing said path at two points, and switching means for selectively connecting and disconnecting said conductors and the adjacent terminals of said winding with and from each other respectively.

28. In an electro-therapeutic machine, the combination of a flat sided resistance winding, two brushes mounted for movement in substantially the same circular path on said winding and oppositely disposed in said path, means imparting continuous operation to said brushes, two conductors extending from two turns of said winding separated from each other and each crossing said path at two points, and switching means for selectively connecting said conductors with each other and with the adjacent terminals of said winding and disconnecting the same as desired.

29. In an electro-therapeutic machine, the combination of a flat sided resistance winding, a first brush mounted for rotary movement on said winding, a second brush electrically connected with said first brush, means imparting continuous operation to said brushes, a contact segment engaging said second brush for part of each rotation of said brushes, and switching means for selectively connecting said segment and a terminal of said winding with each other and disconnecting the same as desired.

30. In an electro-therapeutic machine, the combination of a flat sided resistance winding, a pair of brushes mounted for rotation on said winding, said brushes being diametrically opposed to each other, two additional brushes each electrically connected with one of said pair of brushes, means imparting continuous operation to said brushes, contact segments engaging said additional brushes for part of each rotation of said brushes, and switching means for selectively connecting said segments with the terminals of said winding respectively and disconnecting the same as desired.

31. In an electro-therapeutic machine, the combination of a flat sided resistance winding, a brush mounted for movement in a circular path on said winding, a conductor extending from a turn of said winding crossing said path at two points, means imparting continuous operation to said brushes, a second brush electrically connected with said first brush, a contact segment engaging said second brush for part of each rotation of said brushes, and switching means for selectively connecting said conductor, said segment and a terminal of said winding with each other and disconnecting the same as desired.

32. In an electro-therapeutic machine, the combination of a flat sided resistance winding, two brushes mounted for movement in substantially the same circular path on said winding and oppositely disposed in said path, two conductors extending from two turns of said winding separated from each other and each crossing said path at two points, two additional brushes each electrically connected with one of said first mentioned brushes, means imparting continuous operation to said brushes, contact segments engaging said additional brushes for part of each rotation of said brushes, and switching means for selectively connecting said conductors, and said conductors and said segments with the terminals of said winding and disconnecting the same as desired.

33. In an electro-therapeutic machine, the combination of a motor generator having a shaft, a worm carried by said shaft, a worm wheel meshing with said worm, a friction cone driven by said worm wheel coaxially with the latter, a second shaft supported parallel with an element of said cone, a friction wheel carried by said second shaft and movable longitudinally thereon, devices preventing relative rotation between said second shaft and said friction wheel, said friction wheel having its periphery in frictional engagement with said cone, a flat sided resistance winding, a brush carried by said second shaft for rotation on said winding, and gearing for moving said friction wheel longitudinally on said second shaft towards and from the apex of said cone.

34. In an electro-therapeutic machine, the combination of a motor generator having a shaft, a worm carried by said shaft, a worm wheel meshing with said worm, a friction cone driven by said worm wheel coaxially with the latter, a second shaft supported parallel with an element of said cone, a friction wheel carried by said second shaft and movable longitudinally thereon, devices preventing relative rotation between said second shaft and said friction wheel, said friction wheel having its periphery in frictional engagement with said cone, a flat sided resistance winding, a brush carried by said second shaft for rotation on said winding, gearing for moving said friction wheel longitudinally on said second shaft towards and from the apex of said cone, a second brush carried by said second shaft and electrically connected

with said first brush, and an insulated contact segment engaging said second brush for part of each rotation of said first brush on said resistance winding.

35. In an electro-therapeutic machine, the combination of a motor generator having a shaft, a worm carried by said shaft, a worm wheel meshing with said worm, a friction cone driven by said worm wheel coaxially with the latter, a second shaft supported parallel with an element of said cone, a friction wheel carried by said second shaft and movable longitudinally thereon, devices preventing relative rotation between said second shaft and said friction wheel, said friction wheel having its periphery in frictional engagement with said cone, a flat sided resistance winding, a pair of oppositely disposed brushes carried by said second shaft for rotation on said winding, and gearing for moving said friction wheel longitudinally on said second shaft towards and from the apex of said cone.

36. In an electro-therapeutic machine, the combination of a motor generator having a shaft, a second shaft, gearing connecting said shafts, a friction device carried by said second shaft, a third shaft, a friction wheel carried by said third shaft and movable longitudinally thereon, devices preventing relative rotation between said third shaft and said friction wheel, said friction wheel having its periphery in frictional engagement with said friction device, a resistance winding having contact points in circular arrangement, a pair of oppositely disposed brushes carried by said third shaft for rotation on said contact points, gearing for moving said friction wheel longitudinally on said third shaft along the surface of said friction device, additional brush mechanism carried by said third shaft, and an insulated contact segment engaging said additional brush mechanism for part of each rotation of said pair of brushes.

37. In an electro-therapeutic machine, the combination of rotary brush mechanism for selectively producing slow sinusoidal electromotive force waves of different wave forms, a shaft carrying said brush mechanism, a friction wheel movable longitudinally on said shaft, devices for preventing rotation of said wheel on said shaft, a friction device having its surface in frictional engagement with said wheel to drive the latter, gearing for moving said wheel longitudinally on said shaft and at the same time on the surface of said friction device, and means for rotating said friction device.

38. In an electro-therapeutic machine, the combination of rotary brush mechanism for selectively producing slow sinusoidal electromotive force waves of different wave forms, a shaft carrying said brush mechanism, a friction wheel movable longitudinally on said shaft, devices for preventing rotation of said wheel on said shaft, a friction device having its surface in frictional engagement with said wheel to drive the latter, gearing for moving said wheel longitudinally on said shaft and at the same time on the surface of said friction device, means for rotating said friction device, and contact points of progressively different electrical potential and in circular arrangement differently engaged selectively by said brush mechanism to produce said different wave forms.

39. In an electro-therapeutic machine, the combination of a rotary brush arm for producing a slow sinusoidal electromotive force wave, a shaft carrying said arm, a friction wheel movable longitudinally on said shaft, devices for preventing rotation of said wheel on said shaft, a friction cone having its conical surface in frictional engagement with said wheel to drive the latter, gearing for moving said wheel longitudinally on said shaft and at the same time towards or away from the apex of said cone as desired, means for rotating said cone, contact points of progressively different electrical potential, a brush carried by said arm for engagement by its rotation with said contact points, a conducting segment, and a second brush carried by said arm for engaging said segment during a part of each rotation.

40. In an electro-therapeutic machine, the combination of a rotary brush arm for producing a slow sinusoidal electromotive force wave, a shaft carrying said arm, a friction wheel movable longitudinally on said shaft, devices for preventing rotation of said wheel on said shaft, a friction cone having its conical surface in frictional engagement with said wheel to drive the latter, gearing for moving said wheel longitudinally on said shaft and at the same time towards or away from the apex of said cone as desired, means for rotating said cone, contact points of progressingly different electrical potential in circular arrangement, and two brushes carried by said arm on opposite sides of its axis for engagement by their rotation with said contact points.

41. In an electro-therapeutic machine, the combination of a rotary brush arm for producing a slow sinusoidal electromotive force wave, a shaft carrying said arm, a friction wheel movable longitudinal on said shaft, devices for preventing rotation of said wheel on said shaft, a friction cone having its conical surface in frictional engagement with said wheel to drive the latter, gearing for moving said wheel longitudinally on said shaft and at the same time towards or away from the apex of said cone as desired, means for rotating said cone, contact points of progressingly different electrical potential in circular arrangement, two brushes carried by said arm on opposite sides of its axis for

engagement by their rotation with said contact points, conducting segments, and two additional brushes carried by said arm for engaging said segments for each rotation of said brushes.

42. In an electro-therapeutic machine, the combination of a motor-generator, resistances for determining the form and amount of the voltage delivered to a patient's circuit from said motor-generator, rotary brushes cooperating with one of said resistances, friction gearing for driving said brushes from said motor-generator, devices for changing as desired the ratio of said gearing, switching mechanism for selectively connecting said motor-generator, said resistances, and said brushes in desired circuits, a panel supporting all of said parts below its upper surface, a pair of binding posts carried by said panel for connection with said circuits, and controlling knobs, pointers and dials carried by said panel above its upper surface for controlling said resistances, said gear ratio changing devices and said switching mechanism, whereby said panel and the parts carried thereby comprise all of the working parts of the machine and all of the rotating parts are concealed below the upper surface of the panel.

43. In an electro-therapeutic machine, the combination of mechanism for selectively producing electromotive forces having various slow wave and sinusoidal forms, a panel mounting said mechanism on its lower surface, and controlling devices for said mechanism mounted on the upper surface of said panel, whereby the panel and parts carried thereby comprise a complete and operative machine for the purpose described.

44. In an electro-therapeutic machine, the combination of mechanism for selectively producing electromotive forces having various slow wave and sinusoidal forms, a panel mounting said mechanism on its lower surface, and controlling devices for said mechanism mounted on the upper surface of said panel, whereby the panel and parts carried thereby comprise a complete and operative machine for the purpose described, said mechanism including the rotary parts and switching mechanism of the machine completely protected by said panel, and said controlling devices including devices for operating the switching mechanism and also including devices for changing as desired the frequency and voltage of the electromotive forces produced by the machine.

45. In an electro-therapeutic machine, the combination of devices for producing and selectively delivering to a patient's circuit electric current in different desired wave forms, and a pilot lamp connected with said devices for illumination corresponding with the current wave form delivered.

46. In an electro-therapeutic machine, the combination of a rheostat, switching mechanism for selectively impressing on said rheostat electromotive forces having different wave forms, an output circuit extending from said rheostat, and a pilot lamp connected with said output circuit.

47. In an electro-therapeutic machine, the combination of a casing, a handle rod extending horizontally and substantially parallel with the adjacent side wall of the casing, said side wall having a ledge substantially parallel with said handle rod, and electric heater, and lugs extending from the bottom of said heater to engage one side of said handle rod when said heater rests on said handle rod with one of its edges under said projection, whereby said heater in place on said handle rod is positively restrained against movement towards and away from said casing.

48. In an electro-therapeutic machine, the combination of a casing, a handle rod extending horizontally and substantially parallel with the adjacent side wall of the casing, said side wall having a ledge substantially parallel with said handle rod, and a flat member having parts laterally engaging said handle rod and casing and under the ledge on the latter, restraining said member when in place on said handle rod from lateral movement thereon and permitting the ready removal of said member from said handle rod.

In witness whereof, I hereunto subscribe my name this 23rd day of October, A. D. 1928.

HERMAN P. PULLWITT.

CERTIFICATE OF CORRECTION.

Patent No. 1,764,347. Granted June 17, 1930, to

HERMAN P. PULLWITT.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 15, line 122, claim 16, before "and" insert "brushes having the same cyclic movement on said contacts for either of said conditions of electromotive force distribution"; same page and claim, line 124, beginning with "and brushes" strike out all to and including the word "distribution" in lines 126 and 127; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 6th day of January, A. D. 1931.

M. J. Moore,
Acting Commissioner of Patents.

(Seal)

Nov. 4, 1930. H. P. PULLWITT **1,780,600**

ELECTROTHERAPEUTIC MACHINE

Filed Sept. 26, 1928 6 Sheets-Sheet 1

Fig. 1.

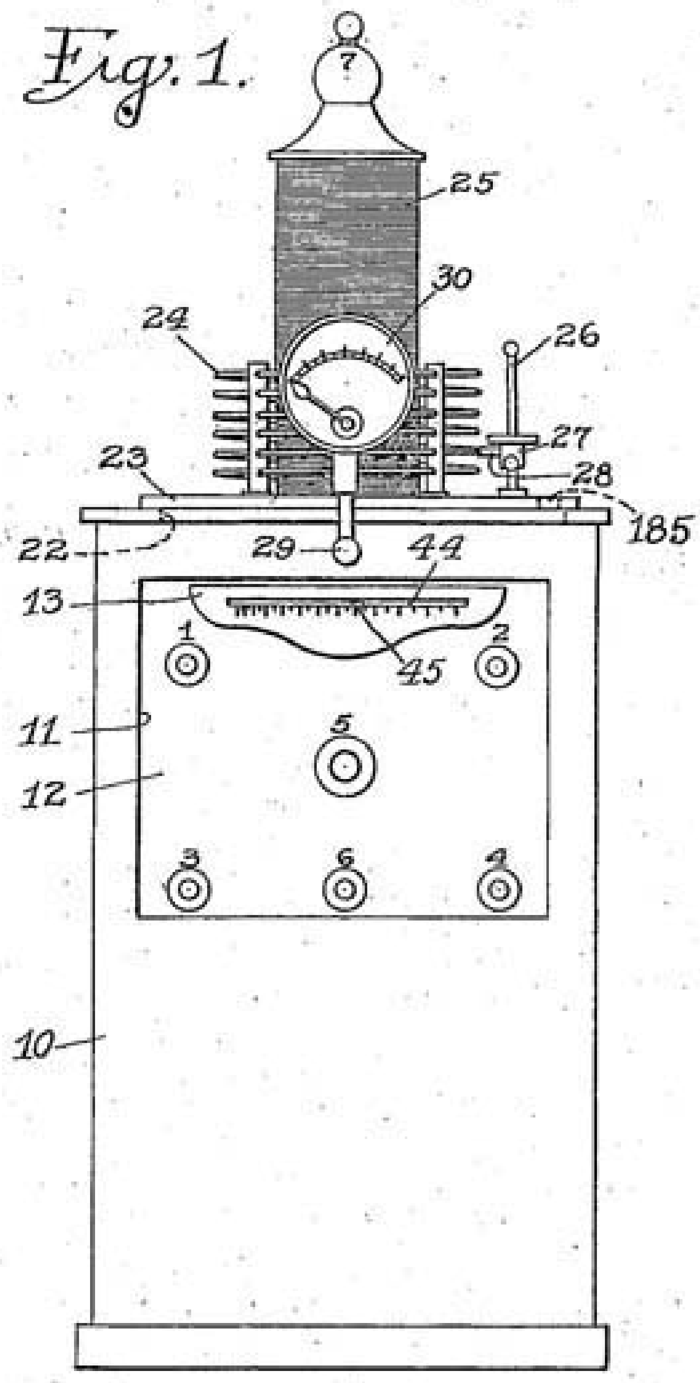


Fig. 2.

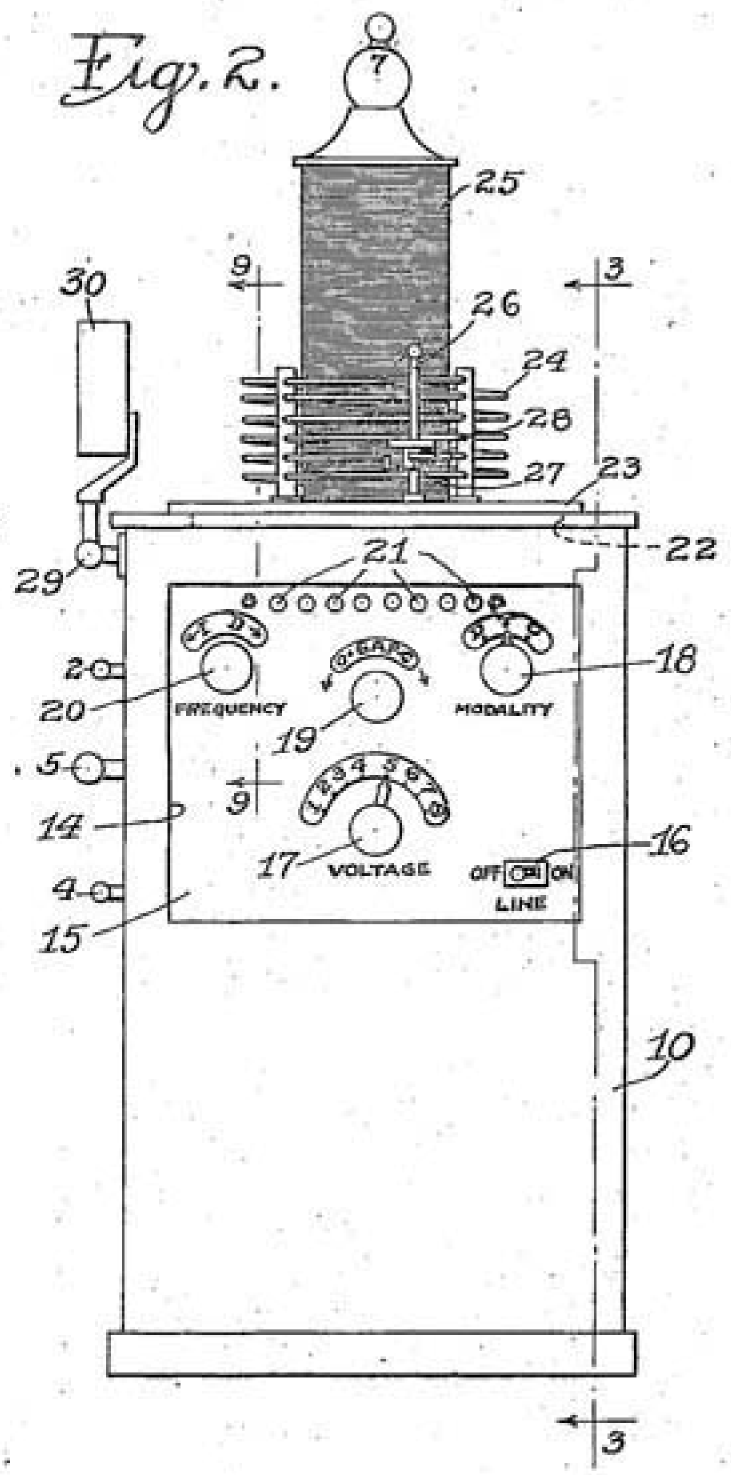
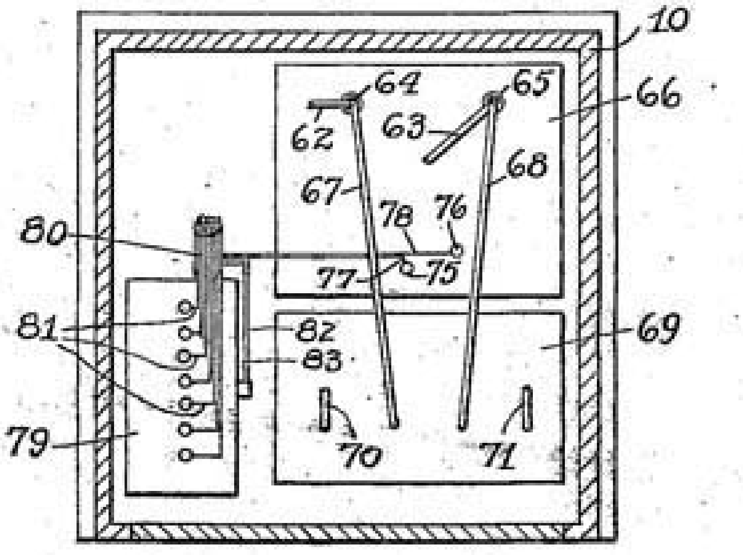


Fig. 4.



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ATTORNEY

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ELECTROTHERAPEUTIC MACHINE

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Fig. 3.

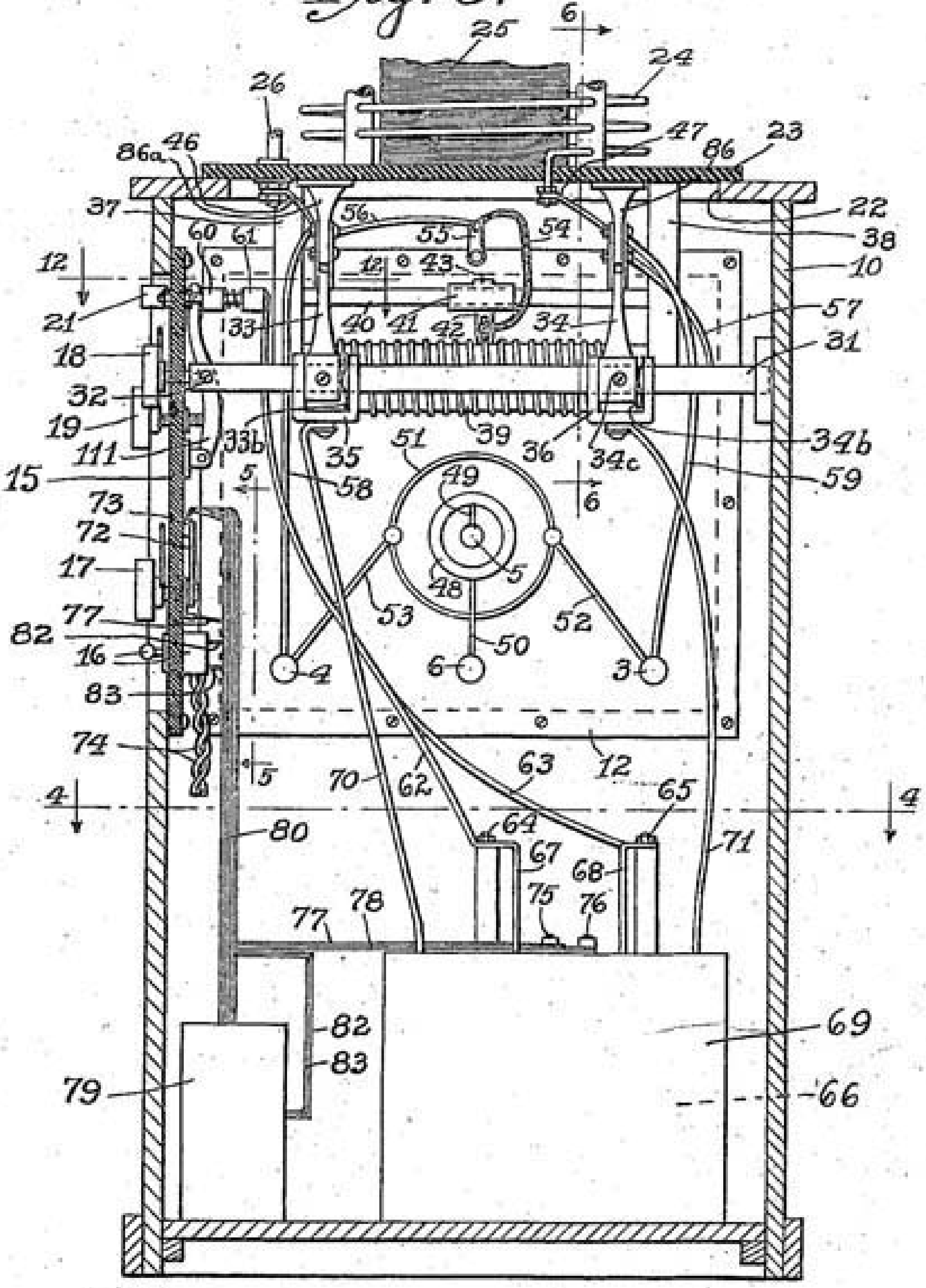
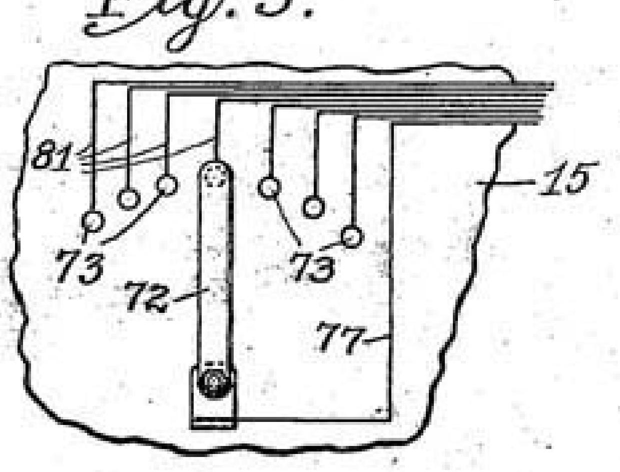


Fig. 5.



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H. P. PULLWITT

1,780,600

ELECTROTHERAPEUTIC MACHINE

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Fig. 9.

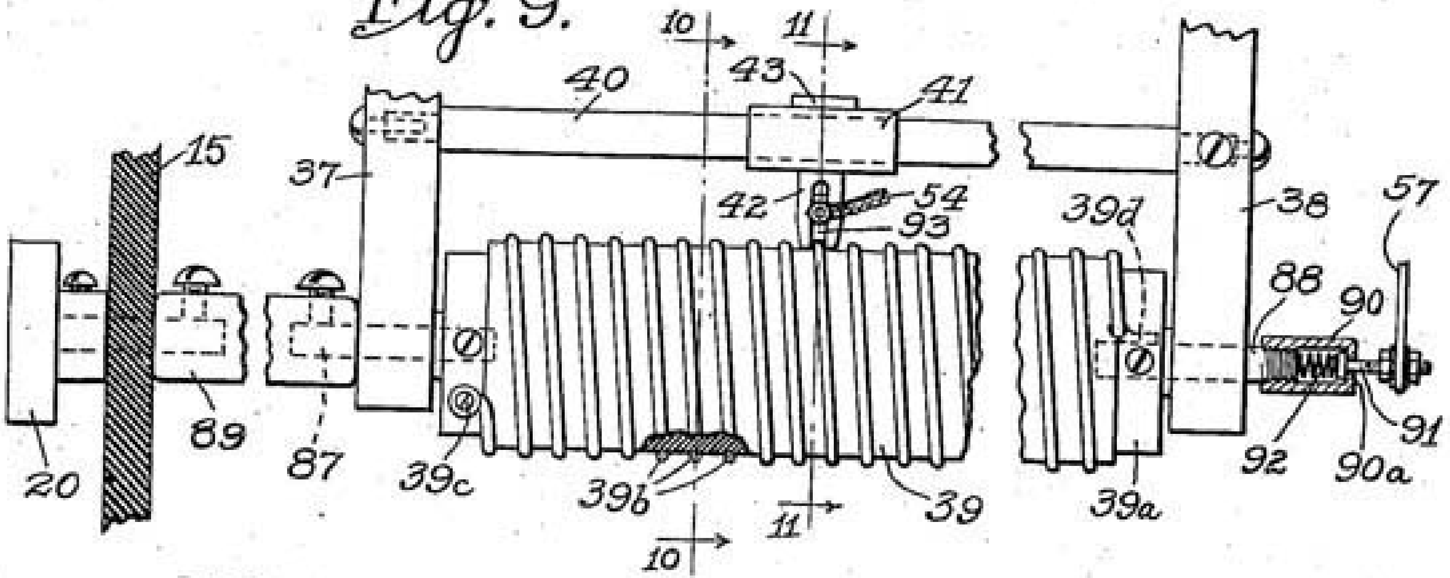


Fig. 10.

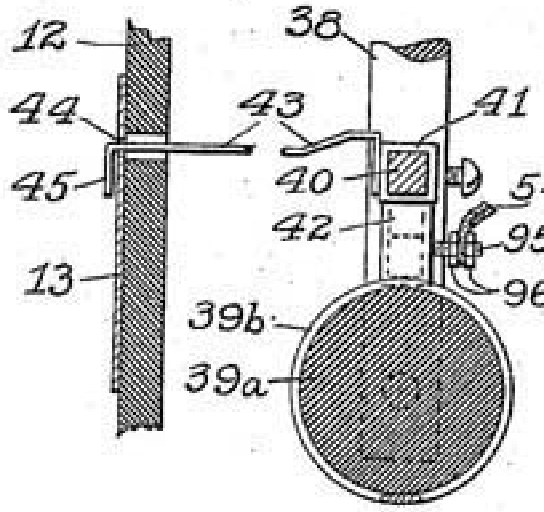


Fig. 11.

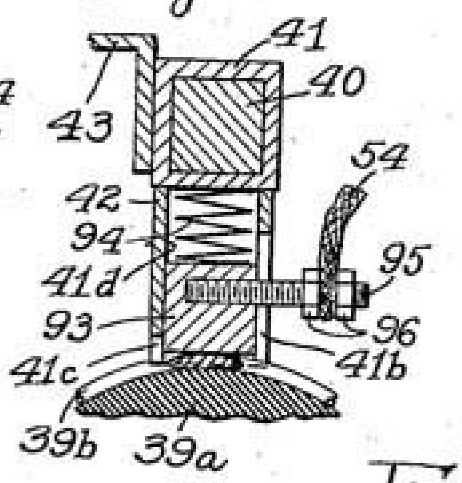


Fig. 8.

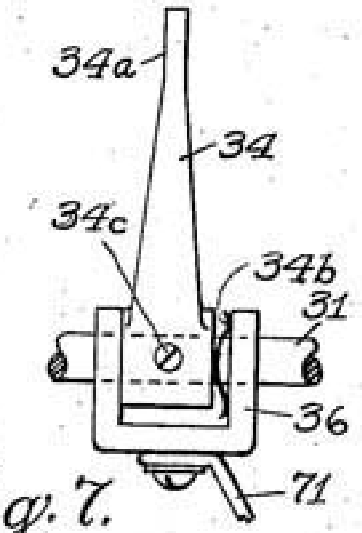


Fig. 6.

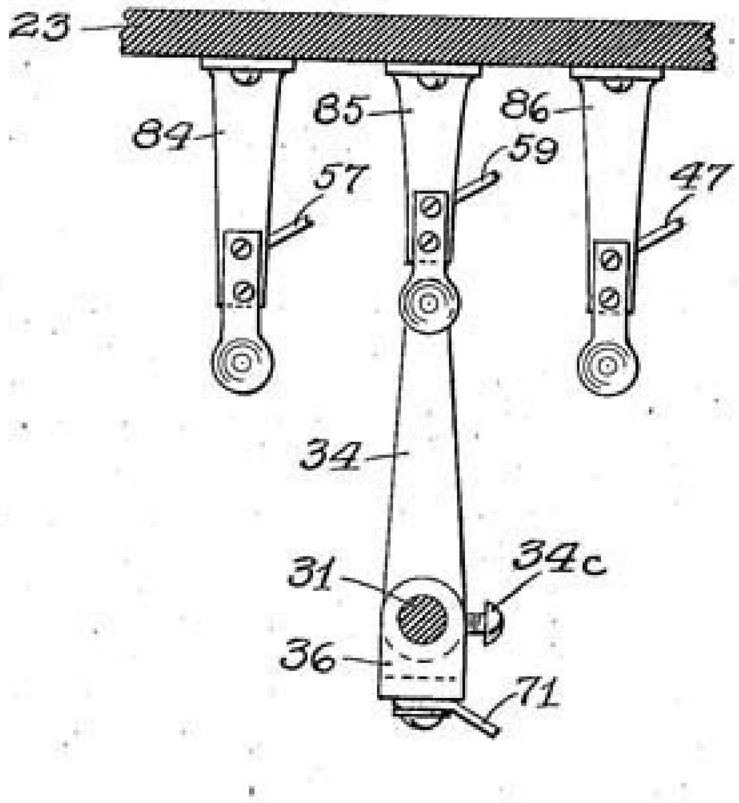
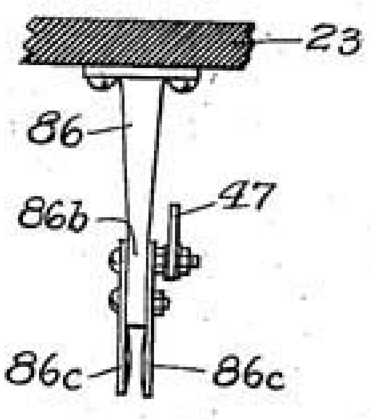


Fig. 7.



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ELECTROTHERAPEUTIC MACHINE

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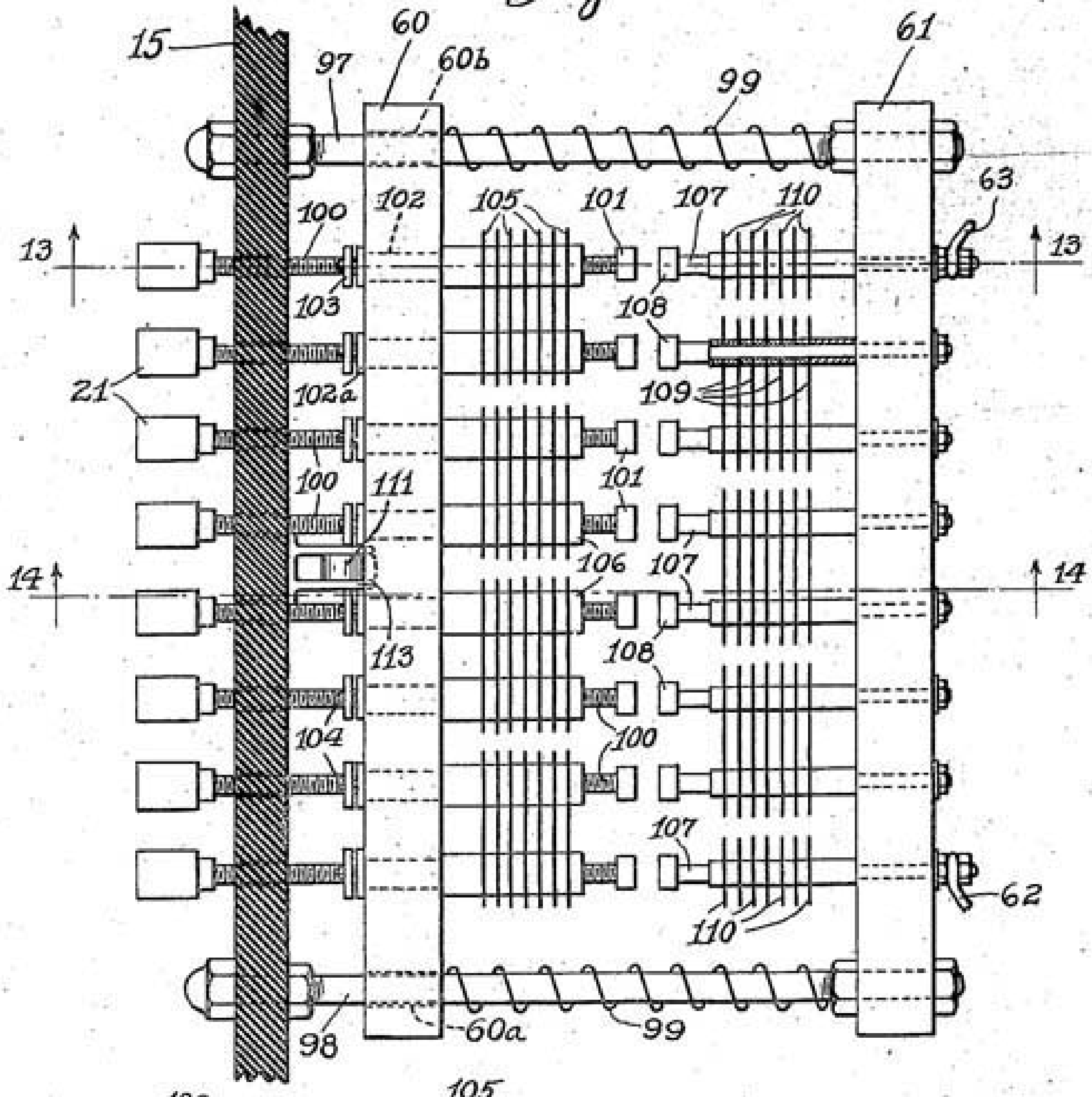
Fig. 12.



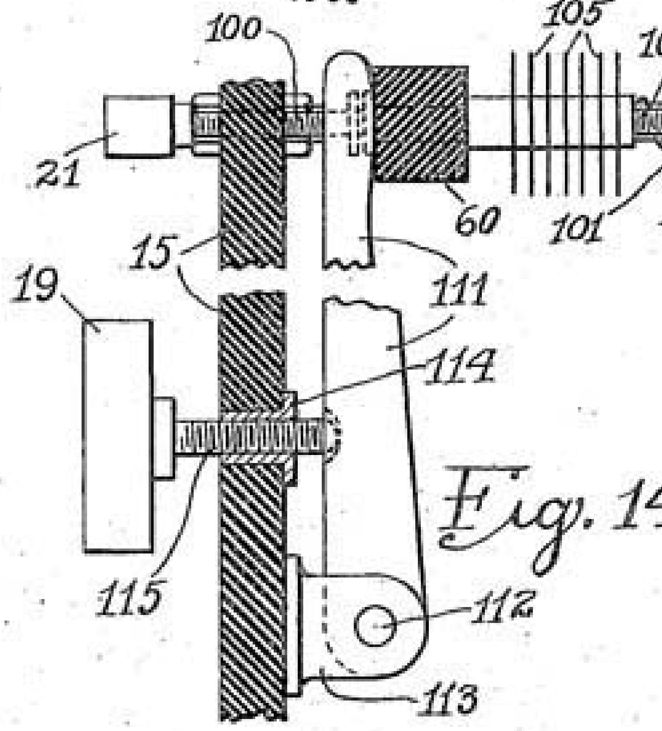
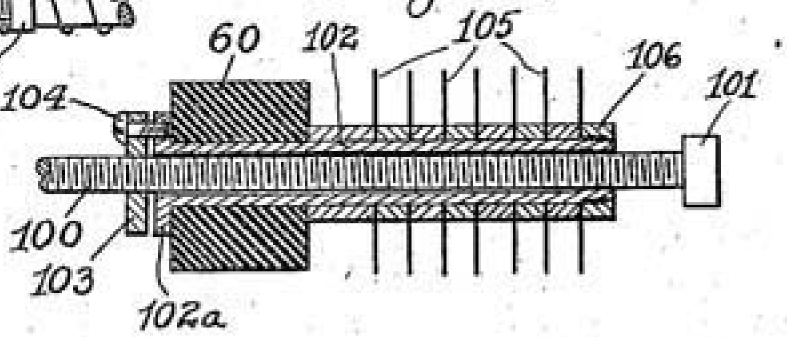


Fig. 14.

Fig. 13.



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ELECTROTHERAPEUTIC MACHINE

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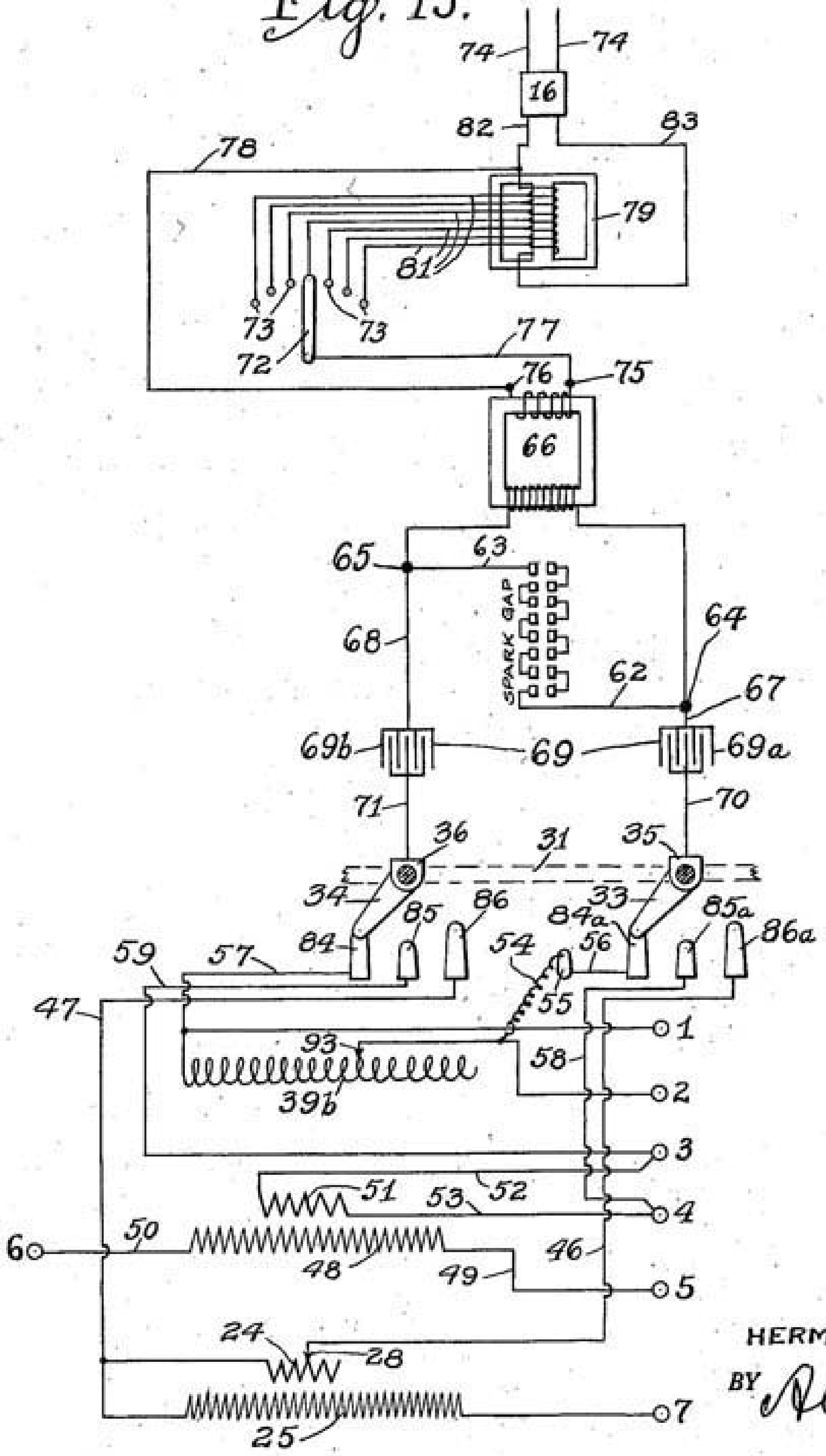
Fig. 15.



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ELECTROTHERAPEUTIC MACHINE

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Fig. 16.

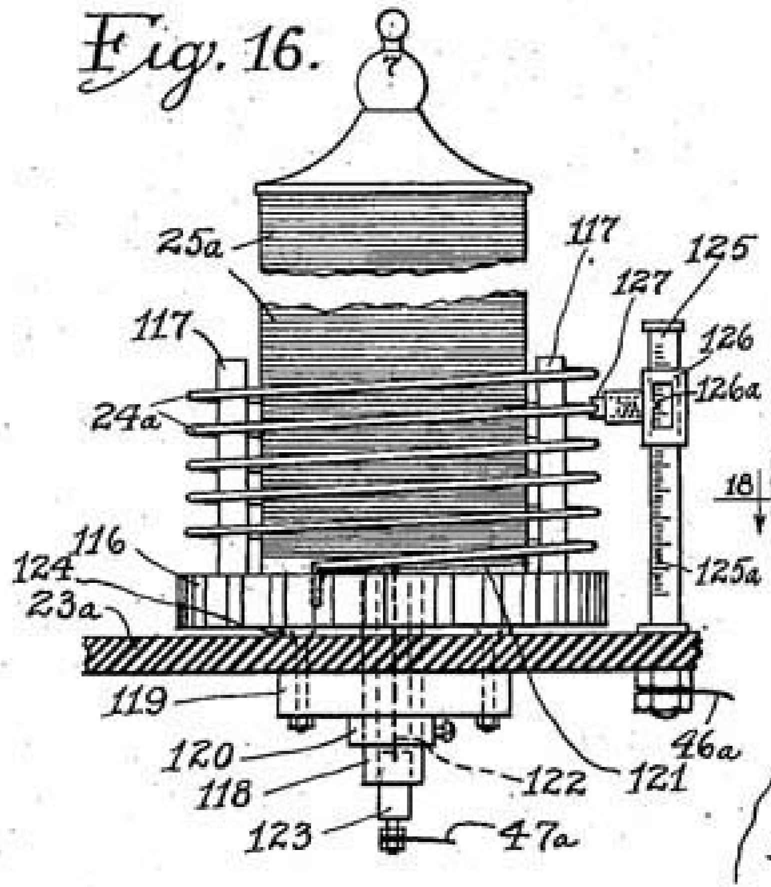


Fig. 17.

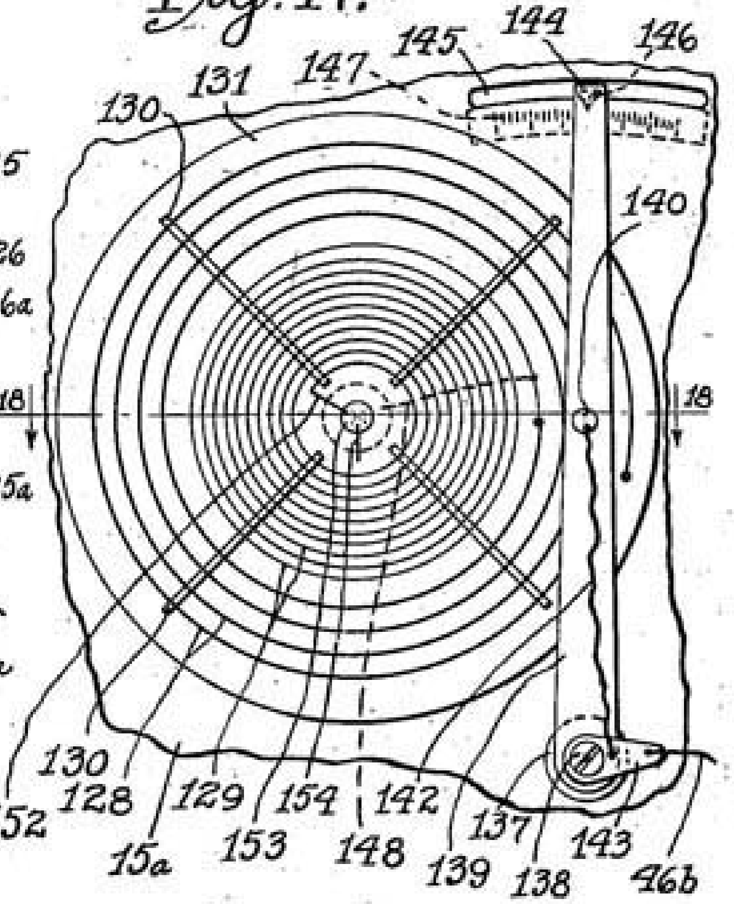


Fig. 19.

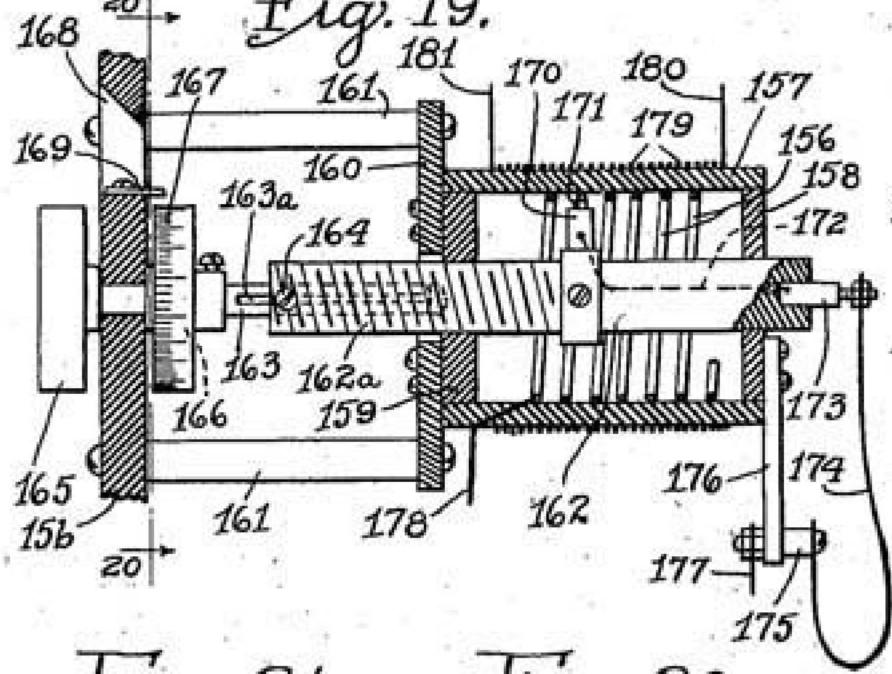


Fig. 18.

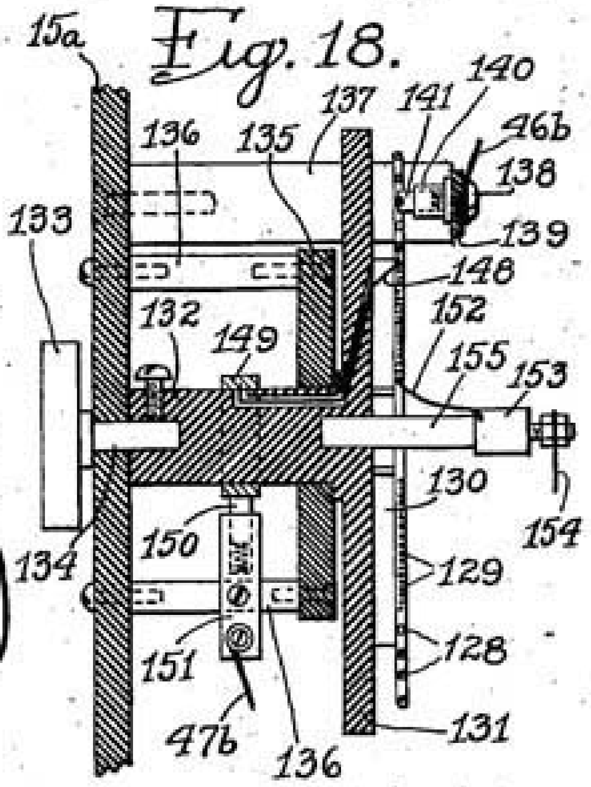


Fig. 21.

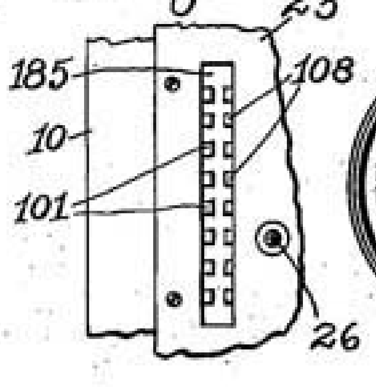
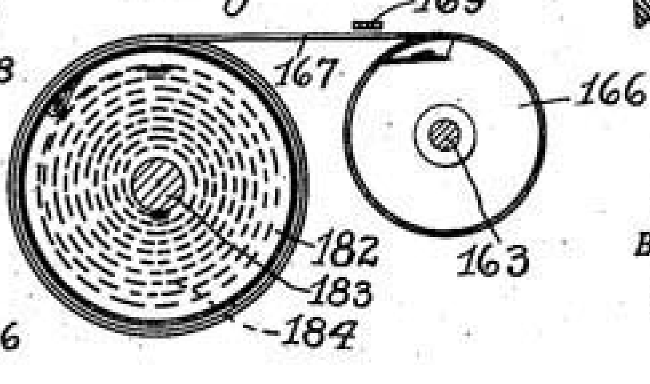


Fig. 20.



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UNITED STATES PATENT OFFICE

HERMAN P. PULLWITT, OF OAK PARK, ILLINOIS, ASSIGNOR TO McINTOSH ELECTRICAL CORPORATION, OF CHICAGO, ILLINOIS, A CORPORATION OF DELAWARE

ELECTROTHERAPEUTIC MACHINE

Application filed September 26, 1928. Serial No. 308,424.

My invention relates to an improvement in electro-therapeutic machines of the class producing high frequency currents of different kinds or modalities, for application in cases generally within the classification of diathermia. In such cases the heating effect of the current of one voltage or another is desired, depending upon the nature of the case, instead of the contractile effect upon the musculature resulting from alternating current of low frequency, from slow sinusoidal current, or galvanic current.

In generating high frequency currents for the purpose contemplated, it is important that there be a means for changing within certain limits, the frequency of the current delivered to the patient's circuit for example from 750 kilocycles to 2200 kilocycles, and it is desirable that the devices employed for changing the frequency of the delivered current, co-operate with means affording a definite indication to the operator of the particular frequency being delivered for any particular setting of the apparatus, and that the apparatus may be set exactly for desired frequencies, since in some cases of treatment very high frequencies are indicated, in other cases much lower frequencies are indicated and in still other cases it is desirable that the frequency applied to the patient shall be an intermediate frequency, although all of these frequencies are of the class known as high frequency currents. In some apparatus of this kind produced in the past, means have been employed for changing the frequency of the current which have been objectionable because of affording changes only by relatively large amounts resulting in coarse steps in the regulation. By my invention, I not only provide devices by which the high frequency may be changed conveniently from one value to another within the range of the apparatus, as well as indicating devices definitely indicating the particular frequency delivered by the apparatus for any particular setting of the frequency changing devices, but I also provide that the change in frequency may be gradual and continuous throughout the entire range of frequencies of the apparatus, thus facilitating an exact setting of the apparatus throughout its entire range of frequencies, for any particular high frequency desired.

In producing high frequency currents for the purpose desired, the apparatus employed includes a means for regulating the voltage of the alternating current applied to the apparatus, a step-up transformer for increasing the voltage of the applied alternating current to a much higher voltage, a spark gap or gaps, a condenser or condensers, and an inductance or inductances, co-operating to determine the frequency of the current flow set up in an oscillatory circuit and delivered to the patient's circuit. In carrying out my invention I make use of a novel type of inductance coil provided with means for varying the inductance of the coil by minute amounts from zero to the maximum inductance of the coil, in such a manner that the variation in inductance is continuous and smooth throughout the entire range of variation from zero to the maximum inductance of the coil, and I also provide a novel form of spark gap construction co-operating with the variable inductance and with the other parts of the apparatus to secure the results above described.

By my invention I also provide means for delivering to the patient's circuit different modalities of the high frequency current, for example relatively low voltage, high frequency current by the inductance coil, for example a d'Arsonval coil, high frequency currents of intermediate voltage, for example by means of a Tesla transformer, and high frequency currents of very high voltage, for example by means of an Oudin resonator.

My invention will best be understood by reference to the accompanying drawings showing a preferred embodiment thereof in which

Fig. 1 shows my machine in front elevation,

Fig. 2 shows my machine in side elevation,

Fig. 3 is a sectional view to an enlarged scale of the parts shown in Fig. 2 taken along the line 3—3,

Fig. 4 is a sectional view of the parts shown in Fig. 3 taken along the line 4—4,

Fig. 5 is a sectional view of some of the parts shown in Fig. 3 taken along the line 5—5,

Fig. 6 is a sectional view of some of the parts shown in Fig. 3 taken along the line 6—6,

Fig. 7 is a rear elevation of one of the switch contacts shown in Fig. 6,

Fig. 8 shows in rear elevation the switch blade shown in Fig. 6,

Fig. 9 is a sectional view to an enlarged scale of a part of the construction shown in Fig. 2, and shows in rear elevation the variable inductance coil employed, this view being taken along the line 9—9 in Fig. 2,

Fig. 10 is a sectional view of the construction shown in Fig. 9 taken along the line 10—10,

Fig. 11 is a sectional view to an enlarged scale of part of the construction shown in Fig. 9 taken along the line 11—11,

Fig. 12 is a sectional view to an enlarged scale of part of the construction shown in Fig. 3 taken along the line 12—12, and shows a top view of the spark gap construction employed,

Fig. 13 is a sectional view of a part of the construction shown in Fig. 12 taken along the line 13—13,

Fig. 14 is a sectional view of the construction shown in Fig. 12 taken along the line 14—14,

Fig. 15 is a diagrammatic drawing of the circuit connections of my machine,

Fig. 16 shows in front elevation, a modified form of Oudin resonator by which the inductance of the primary winding may be varied in substantially the manner indicated for the inductance coil shown in Fig. 9,

Fig. 17 shows in rear elevation, a modified form of inductance coil of the pan-cake type as distinguished from the helical form of coils shown in Figs. 9 and 16, together with devices for continuously varying the inductance by infinitely small amounts throughout the entire inductance range of the coil,

Fig. 18 is a sectional view of the parts shown in Fig. 17 taken along the line 18—18,

Fig. 19 is a longitudinal, sectional view through a modified form of helical inductance coil having a support surrounding the coil, together with devices for continuously varying the inductance of the coil by infinitely small amounts throughout the entire inductance range of the coil,

Fig. 20 is a sectional view of part of the construction shown in Fig. 19 taken along the line 20—20, and

Fig. 21 shows in plan view a part of the side edge portion of the top of the casing shown in Figs. 1 and 2.

Similar numerals refer to similar parts throughout the several views.

As shown in Figs. 1 and 2 my machine consists of a cabinet 10 having an aperture 11 in its front wall and supporting a first panel 12 of insulating material, which panel in turn supports the several binding posts 1, 2, 3, 4, 5 and 6 of the patient's circuit, and the indicating scale 13 of the frequency changing devices.

One side wall of the machine, for example the right hand side wall as illustrated in Fig. 2, is provided with an aperture 14 which is closed by a second insulating panel 15 carrying a line switch 16, a first knob 17 for changing as desired, the voltage of the alternating current delivered to the high frequency producing devices, a second knob 18 for selecting a desired modality or voltage of high frequency current to be delivered to the patient's circuit, a third knob 19 for changing the adjustment of the spark gap as a whole, as desired, and a fourth knob 20 for varying the frequency as desired. In addition to the knobs described, the panel 15 also carries a plurality of smaller knobs 21 for individually adjusting as desired, the several electrodes of the spark gap.

The top of the cabinet is provided with an aperture 22 closed by a third panel 23 of insulating material, which besides supporting below it, the current controlling devices in a manner to be described, carries above it, the primary winding 24 and the secondary winding 25 of a high voltage Oudin resonator. The mounting of the secondary winding 25 carries at its upper end a post or electric connection 7 to constitute a part of the patient's circuit when the Oudin resonator is used. The panel 23 also supports a metal post 26 carrying an adjustable sleeve 27, which sleeve in turn carries a contact spring 28 for engaging a desired turn of the primary winding 24 so that by moving the sleeve 27 vertically on the post 26 the amount of the primary winding 24 included in the circuit may be changed by any desired number of complete turns of the primary winding 24.

The front of the cabinet 10 carries a bracket 29 which in turn supports a current measuring device 30, for example a milliammeter responsive to high frequency alternating current flow, for indicating the amount of current flowing in the patient's circuit.

As shown in Fig. 3, a shaft 31 of insulating material, for example a phenol condensation product, is supported in horizontal position by the panel 15 and the opposite wall of the cabinet 10, in line with the modality selecting knob 18, from which an operating rod extends through the panel 15 into the shaft 31 to which it is rigidly secured by a set screw 32. The shaft 31 has rigidly secured thereto, switch blades 33 and 34 to selectively engage switch contacts carried by the panel 23 in a manner to be described. The shaft 31 also carries around the ends of the blades 33 and 34, metal yokes 35 and 36 which are rotary relatively to the shaft 31 and held in contact with the blades 33 and 34 respectively by flat springs 33^b and 34^b as indicated.

Between the shaft 31 and the panel 12, posts 37 and 38 are rigidly secured to the panel 23 and extend downwardly therefrom to form the end bearing supports of the inductance coil 39 which is supported by said posts 37 and 38 in line with the knob 20. The posts 37 and 38 also support above the inductance coil 39 and parallel therewith, a flat sided metal bar 40 carrying a metal slider 41 from which a contact arm 42 extends downwardly to engage the winding of the inductance coil 39, and from which an arm 43 extends upwardly and forwardly, to project through the slot 44 in the scale 13 to carry an indicating pointer 45 in front of and adjacent the indications of said scale.

The post 26 extends through the panel 23 as indicated, and is connected by wire 46 with one of the switch contacts co-operating with the switch blade 33, and the lower terminal of the primary winding 24 extends through the panel 23 and is connected by wire 47 with one of the switch contacts associated with the switch blade 34.

The panel 12 carries back of the binding post 5 the secondary winding 48 of a high frequency Tesla transformer, one terminal of which winding is connected by wire 49 with the binding post 5, the other terminal of said winding being connected by wire 50 with binding post 6 of the patient's circuit. The secondary winding 48 is surrounded by a primary winding 51, the terminals of which are connected by wires 52 and 53 with binding posts 3 and 4 of the patient's circuit.

The slider 41 is connected by a flexible wire 54 with a connector clip 55 supported in stationary position by the cabinet, this clip being connected by wire 56 with one of the switch contacts co-operating with the switch blade 33. The other terminal of the inductance coil 39 is connected by wire 57 with one of the switch contacts co-operating with the switch blade 34, and the other switch contacts co-operating with the switch blades 33 and 34 respectively are connected by wires 58 and 59 with binding posts 4 and 3 respectively of the patient's circuit.

Bars of insulating material 60 and 61, for example lava, constituting the insulating supports of the spark gap construction, are mounted on the panel 15 and behind it in the position indicated, and from the spark gap construction, wires 62 and 63 extend to the high potential terminals 64 and 65 respectively of the secondary winding of the step-up transformer 66 located in the lower part of the cabinet 10. The terminals 64 and 65 are also connected by wires 67 and 68 with terminals of the condenser 69. The remaining terminals of the condenser 69 are connected by wires 70 and 71 with the yokes 35 and 36 respectively.

The panel 15 carries on a rod extending from the knob 17, and back of the panel, a switch blade 72 co-operating with switch contacts 73, to vary the voltage of alternating current supplied to the high frequency producing devices. Current is supplied to the line switch 16 by main alternating current conductors 74, and the voltage delivered to the primary winding terminals 75 and 76 of the transformer 66 through wires 77 and 78, is conveniently varied by means of an auto-transformer 79 located in the lower part of the cabinet 10 and controlled by the switch blade 72. The circuit connections between the line switch 16, the switch blade 72, the switch contacts 73, the primary terminals 75 and 76 and the auto-transformers 79, are conveniently grouped in a cable 80.

The relation of the transformer 66 and the condenser 69 to each other, and the circuit connections extending from these devices, are more clearly shown in Fig. 4. As shown in this figure, wires 81 extend from taps of the auto-transformer 79 through the cable 80 to the switch contacts 73 as more clearly shown in Fig. 5, the switch blade 72 being connected with the wire 77 extending to the primary terminal 75 of the transformer 66. The cable 80 also contains wires 82 and 83 extending to the terminals of the winding of the auto-transformer 79, from the line switch 16.

As shown in Fig. 6, the switch blade 34 may by operation of the shaft 31, selectively engage any one of the switch contacts 84, 85 and 86 mounted on the panel 23, which contacts are connected with wires 57, 59 and 47 respectively. Each of the switch contacts, as shown for the switch contact 86 in Fig. 7, comprises a metal post extending downwardly from a flanged base, which post at its lower end, is flattened as indicated at 86^b, and has secured to its opposite sides, switch jaws 86^c of spring metal to make positive contact with the flattened upper end 34^a of the switch blade 34 shown in Fig. 8. The lengths and separation of the switch contacts and the length of the switch blade, are such as to insure ample separation between the switch contacts in view of the high voltages employed. As shown in Fig. 8, the switch blade 34 is secured to the shaft 31 by means of a set screw 34^c. The other switch blade 33 is of the same construction as the switch blade 34 and similarly carried by the shaft 31, and engages similar switch contacts 84^a, 85^a and 86^a, which are therefore not shown in detail.

As shown in Fig. 9, the inductance coil 39 comprises a cylindrical core 39^a of insulating material upon the surface of which the winding 39^b of the coil is wound with its turns spaced from each other in a shallow helical groove in the outer surface of the core. The core has extending from its ends, metal shafts

87 and 88, which are secured to the core by set screws as indicated and extend respectively through the posts 37 and 38 to support the coil 39 for rotary movement. The shaft 87 is in line with the axis of the shaft extending through the panel 15 from the knob 20, and these two shafts are connected by a rod or sleeve 89 of insulating material by set screws as indicated. The shaft 88 carries on its outer end a sleeve 90 through the apertured end wall 90^a of which a contact stud 91 extends, said stud being headed on its inner end and held in firm electrical contact with the end wall of the sleeve 90, by a spring 92, to permit rotation of the sleeve with the inductance coil 39, without rotation of the contact stud 91. The stud 91 is threaded on its outer end and carries suitable threaded nuts to permit making electrical connection with the stud. The winding 39^b is secured at one end to the core 39^a in any convenient manner, for example by a screw 39^c as indicated, and the other end of the winding is extended through the core into electrical contact with the shaft 88 as indicated at 39^d.

The slider 41, as more clearly shown in Figs. 10 and 11, comprises a tubular body portion of the conformation of the flat sided bar 40, and a sliding fit thereon, and a contact arm 42 extending downwardly from the tubular portion to contain a contact block 93, the lower end of which rests upon the winding 39^b at any point of the winding at which the slider may be. The arm 42 is slotted in its front and rear walls as indicated at 41^b and 41^c to just clear the wire of the winding 39^b and the contact block 93 is a sliding fit in a flat sided bore 41^d in the said bore. A spring 94 is contained in the bore 41^d to press the contact block 93 against the winding 39^b. The slot 41^b extends upwardly to a sufficient extent so that a threaded post 95 carried by the contact block 93 may extend through said slot, the outer threaded end of the post having thereon threaded nuts 96 to facilitate making electrical connection with the contact block 93.

As shown in Fig. 12, the spark gap bar 61 is rigidly mounted on rods 97 and 98 from the panel 15 in substantially horizontal position by means of nuts threaded on said rods as indicated. The bar 60 is provided with clearance holes 60^a and 60^b, through which the rods 98 and 97 extend, so that the bar 60 may slide upon said rods. Springs 99 are mounted on the rods 97 and 98 between the bars 60 and 61 to tend to maintain the bars in separated relation from each other. The bar 60 carries a plurality of metal rods 100, extending through clearance openings therefor through the panel 15 and carrying at their outer ends the adjusting knobs 21. The inner ends of said rods are provided with gap electrodes of refractory material 101, for example tungsten. As more clearly shown in Fig. 13, each of the rods 100 is threaded its entire length and engages corresponding internal threads in a metal sleeve 102, rigidly mounted in the bar 60, the threaded end of the sleeve projecting from the bar 60 towards the bar 61 and terminating adjacent the electrode 101. The other end of the sleeve 102 is flanged outwardly as indicated at 102^a, and adjacent this flange, the rod 100 carries a threaded disk 103 engaging the threads of the rod, which disk is secured to the flange 102^a by a screw 104 in such a manner that tightening or loosening the screw increases or decreases the friction upon the screw threads of the rod 100 and thus provides a convenient means for securing any desired degree of tightness of the co-operating threads and any desired adjustment of the turning effort required to rotate the rod. The projecting end of the sleeve 102 has mounted thereon a plurality of thin metal plates 105 which are preferably of high heat conductivity, for example copper, which plates are held in place by washers as indicated and a nut 106 threaded on the end of the sleeve 102. As indicated in Fig. 12 the plates 105 are secured in the manner described to the sleeves of two adjacent rods 100, and in this manner the rods 100 indicated as connected by these plates are electrically connected together. The bar 61 carries a plurality of rods 107 similar to the rods 100 except that they are rigidly supported in fixed position by the bar 61 to extend towards the rods 100 and on their ends adjacent the electrodes 101, these rods 107 carry gap electrodes 108. The rods 107 are connected by radiating plates 109 similar to the plates 105, the difference being that each connected pair of rods 107 carries electrodes co-operating with one electrode of each of two connected pairs of the rods 100 so that the electrical connections effected by the plates 105 and 109 serve to connect the individual spark gaps between the electrodes 101 and 108, in series arrangement. The end rods 107 are provided with radiating plates 110 which are individual to these rods and are therefore of smaller extent than the radiating plates 109, since these end rods 107 are not electrically connected with any of the other rods of the spark gap construction. The end rods 107 carry suitable threaded nuts adjacent the bar 61 to connect the wires 62 and 63 to the said end rods.

As more clearly shown in Fig. 14, an operating lever 111 is pivotally mounted at its lower end as indicated at 112, on a bracket 113 supported by the panel 15 below the knob 19. A threaded metal bushing 114 is inserted in the panel 15 co-axially with the axis of the knob 19, and a threaded rod 115 carried by the knob 19 engages internal threads in the bushing 114 and extends through the bushing to engage the lever 111, so that turning the knob 19 moves the lever away from the panel 15 or permits it to move towards the panel 15, according to the direction of rotation of the knob 19. The upper end of the lever 111 extends between two of the rods 100 and engages the midportion of the front face of the bar 60 in a manner to prevent the springs 99 from moving the bar 60 towards the panel 15 further than the position of the lever 111 will permit.

As a result of the construction just described, it will appear that each of the individual gaps of the spark gap may be adjusted by turning the corresponding one of the knobs 21 and that when all of the individual spark gaps are in desired adjustment, turning the knob 19 will move all of the spark gap electrodes 101 substantially equal amounts towards or away from the electrodes 108, and thus afford a convenient means for quickly securing any length of spark gap desired.

In Fig. 15 I show diagrammatically, the circuit connections of the machine as a whole, and it is thought that in view of the description above given of the connection of the various wires to the different parts of the apparatus, further description of the circuits is not needed. As shown in Fig. 15, the condenser 69 consists of two sections 69^a and 69^b, connected in series respectively with the wires 67 and 70, and the wires 68 and 71, extending from the high voltage secondary winding of the transformer 66, to the modality switch blades 33 and 34.

From the circuit connections shown in Fig. 15 it will at once appear that with the switch blades 33 and 34 in the position indicated, the spark gap, the condenser sections and the accurately adjustable inductance 39 provide a means for accurately producing and delivering high frequency current to the patient's posts 1 and 2 of any particular frequency desired within the range of frequencies of the apparatus, and further that the spark gap construction may readily be adjusted so that it will most effectively set up high frequency current flow in the oscillatory circuit just referred to.

In some cases I find it desirable to provide the Oudin resonator with devices for continuously changing the inductance of the coil connected with and forming a part of the oscillatory circuit, so that the changes are of infinitely small amount throughout the entire range of inductance of the winding, instead of using the coarse step adjustment secured by the conventional devices shown in Figs. 1 and 2. To accomplish this, as illustrated in Fig. 16, the primary and secondary windings 24^a and 25^a of the resonator, may be mounted on a rotary base 116, preferably of insulating material, the primary winding 24^a being supported around the secondary winding 25^a in concentric relation by posts 117 carried by the base 116, and the convolutions of the primary winding being so supported that contact may be made continuously with the outer surface of the winding from one of its ends to the other. The base 116 is provided with a downwardly extending central tube 118, preferably of insulating material, which extends through the panel 23^a and through a bearing block 119 secured to the under surface of the panel. The tube 118 projects below the block 119 and carries a collar 120 to hold the base 116 in place. The lower ends of the primary winding 24^a and the secondary winding 25^a are connected by a wire 121 and this connecting wire has connected with it a second wire 122 extending through the tube 118 to a contact terminal 123 of a construction similar to that described above for the terminal 90 in connection with Fig. 9. A washer 124, preferably of insulating material, is carried by the panel 23^a around the tube 118, to reduce the turning friction of the rotary base 116. The panel 23^a carries a metal post 125 at one side of the base 116, which post is preferably flat sided and carries a slider 126 having a similar shaped bore, so that the slider may move vertically on the post 125, but be prevented from turning on the post. The slider carries a contact 127 of the plunger type, in engagement with the outer surface of the wire of the primary winding 24^a, said slider and contact being constructed similarly to the slider 41 and its contact 93, shown and described in connection with Figs. 9 and 11 above, the principal difference being that the outer end of the contact 127 is grooved so that the contact has sufficient lateral engagement with the wire of the primary winding 24^a, to move the slider 126 vertically on the post 125, when the base 116 is rotated. The post may conveniently carry a scale 125^a, and the corresponding wall of the slider 126 may be apertured and provided with a pointer 126^a for indicating in any desired units, the frequency of the current flow resulting from any particular adjustment of the base 116.

The connector 123 and the post 125 are connected with wires 47^a and 46^a, which may be connected in the same manner as above described for the wires 47 and 46 respectively, with the remaining parts of the apparatus diagrammatically illustrated in Fig. 15.

To facilitate rotation of the base 116 I prefer to flute its outer edge, or otherwise provide it with convenient means for engagement by the hand of the operator.

In Fig. 17 I show in elevation, an inductance coil of the flat or pan-cake type for use where the type of coil shown in Figs. 9 and 16 is not preferred. In this construction, a primary winding, spiral in form is shown at 128, and similarly wound within the primary winding and substantially in the same plane, a secondary winding is shown at 129. The windings 128 and 129 may be conveniently supported in the position shown, by bars 130 of insulating material carried by a disk 131 also preferably of insulating material. As shown in Fig. 18, the disk 131 is provided with a cylindrical shaft portion 132 extending away from the windings 128 and 129, towards a supporting panel 15^a. An adjusting knob 133 rigidly carries a rod 134 extending through the panel 15^a and into the end of the shaft portion 132 to which it is rigidly secured by a set screw as indicated. The other end of the shaft portion 132, is supported by a bearing disk 135, held in place by posts 136 supported by the panel 15^a. The construction described supports the windings 128 and 129 so they may be rotated about the axis of the shaft portion 132, by turning the knob 133.

The panel 15^a also supports another post 137, preferably of insulating material, which extends rearwardly beyond the disk 131, to carry the pivotal support 138 of a swinging arm 139, preferably of insulating material, said arm being mounted to swing in a plane substantially parallel with the windings 128 and 129. The arm 139 carries a metal contact housing 140 substantially in line with the horizontal diameter of the windings 128 and 129, and this housing 140 carries a plunger contact 141 having a grooved end engaging the wire of the primary winding 128, depending upon where the arm happens to be relatively to the winding. The contact 141 is preferably cylindrical and may turn in its housing 140 and thus, when the disk 131 is rotated, the contact 141 remains continuously in contact with the wire of the winding 128 from one end to the other of said winding, and the part of the winding connected in an oscillatory circuit may be varied as desired by infinitely small amounts throughout the entire inductance range of the coil. The contact housing 140 is preferably connected by a flexible wire 142 with a connector clip 143, held in place by the arm supporting pivot 138, and the clip 143 may also have connected with it one terminal wire of the device as indicated at 46^b.

The arm 139 may be extended beyond the contact housing 140 and carry at its upper end an arm 144 extending horizontally towards the panel 15^a and through a slot 145 in said panel, to carry on its outer end a pointer 146 co-operating with a scale 147 indicating in any desired units, the frequency of the current in the oscillatory circuit of which the winding 128 is a part, for any adjustment of the winding relatively to the contact 141.

The adjacent ends of the windings 128 and 129 may be connected together as indicated, and this connection may be connected by wire 148 with a metal contact or slip ring 149 carried by the shaft portion 132. The contact ring 149 is engaged by a plunger contact 150 carried by a contact housing 151 supported by one of the posts 136, and the other terminal wire 47^b of the device, may be connected with the contact housing 151 in any convenient manner as indicated.

The inner end of the secondary winding 129 may be connected by wire 152 with a contact terminal 153 of the type shown for the contact terminal 90 in Fig. 9 above, and a wire 154 may extend from the contact terminal 153 to connect one terminal of the secondary winding 129 in circuit as desired. The contact terminal 153 may conveniently be supported by a post 155, preferably of insulating material extending co-axially and rearwardly from the disk 131 which carries it.

Where the device shown in Figs. 17 and 18 is constructed for use as a resonator, the wires 46^b and 47^b may be connected with the remaining parts of the apparatus shown diagrammatically in Fig. 15 in the same manner that the windings 24 and 25 are shown as connected with said remaining parts by the wires 46 and 47 in said figure, and in that case the wire 154 extends to a high tension terminal of the patient's circuit corresponding with the terminal 7 shown in Fig. 15.

In Fig. 19, I illustrate a further modified form of variable inductance, in which the inductance may be changed by continuous and infinitely small amounts throughout the entire range of inductance of the coil, which may readily be used as a d'Arsonval type of coil, as an Oudin resonator transformer or as a Tesla transformer as desired, depending upon whether a secondary winding is employed with the variable inductance winding, and if it is employed, the manner in which it is connected. In this construction, an inductance winding 156 is shown as wound on the inner surface of a tube 157 of insulating material, which tube is provided with end disks 158 and 159 of insulating material, the disk 159 being secured to a supporting disk 160, preferably of insulating material, supported substantially parallel with a panel 15^b by posts 161, preferably of insulating material, and carried by the panel, so that the axis of the tube 157 is substantially perpendicular with the panel 15^b. The end disk 159 of the tube 157, is bored and threaded to engage corresponding threads 162^a on a shaft 162 of insulating material, co-axially mounted in the tube 157 and extending with a sliding fit through the end disk 158. The threaded end of the shaft 162 is bored to receive the end portion of an operating shaft 163, the latter shaft being provided with a keyway 163^a engaged by the end of a screw 164 carried by the threaded end of the shaft 162, in a manner to prevent relative rotation between the shafts 162 and 163, but at the same time permitting the shaft 162 to move axially relatively to the shaft 163. The shaft 163 extends through the panel 15^b and has rigidly secured to its outer end, an operating knob 165. Inside of the panel 15^b, the shaft 163 also has rigidly secured to it, a wheel 166 carrying a scale of flexible material 167, visible to the operator, through a sight opening 168 in the panel 15^b, the particular adjustment of the device being indicated on the scale 167 at any instant by the pointer 169.

The shaft 162 is provided inside of the winding 156, with a contact housing 170, extending radially from the shaft 162 towards the winding 156. The housing 170 carries a plunger contact 171 engaging the inner surface of the wire of the winding 156, and the pitch of the threads 162^a of the shaft 162 is the same as the pitch of the turns of the winding 156, as a result of which, turning the shaft 162 maintains the contact 171 in engagement at all times with the inner surface of the winding 156, and at a point at any time, determined by the axial and angular positions of the shaft 162 resulting from its rotation. The contact housing 170 may be conveniently carried by the shaft 162 in any desired manner and is connected by a wire 172 with a contact terminal 173 carried by the end of the shaft 162 and of the same type shown and described for the contact terminal 90 in connection with Fig. 9 above. The contact terminal 173 may conveniently be connected with a flexible wire 174, the other end of which extends to a terminal post 175 carried by an arm 176 of insulating material extending from the end disk 158, and the contact terminal 175 may be connected with one of the terminal wires 177 of the device. The end of the winding 156 adjacent the supporting disk 160, may conveniently extend to the other terminal wire 178 of the inductance coil, and when the coil is used as a plain inductance winding of the d'Arsonval type, the terminal wires 177 and 178 may be connected with the rest of the apparatus illustrated diagrammatically in Fig. 15 by connecting the wires 177 and 178 in the same manner that the wires 56 and 57 are shown as connected in Fig. 15, in which case the winding 156 would replace the inductance winding 39^b of Fig. 15.

If desired, the device shown in Fig. 19 may be provided with a secondary winding 179 wound on the outer surface of the tube 157, or wound in a manner to surround the tube, so that it is inductively related to the winding 156, which winding then constitutes the primary winding of a transformer of the Tesla type. With this construction, in using the device instead of the Tesla coil above described, in connection with the rest of the apparatus shown diagrammatically in Fig. 15, the terminal wires 180 and 181 of the secondary winding 179, are connected in the manner shown and described above for the wires 49 and 50 and the terminal wires 177 and 178 are connected as shown and described above for the wires 52 and 53.

Where the device shown in Fig. 19 is used as an Oudin resonator, in connection with the other apparatus shown diagrammatically in Fig. 15, the wires 178 and 181 are connected with the switch contact 86 in the manner shown for the wire 47, the wire 177 is connected in the manner shown for the wire 46, and the wire 180 extends to a terminal of the patient's circuit as illustrated at 7 in Fig. 15.

As shown in Fig. 20, the flexible scale 167 extends from the wheel 166 to a drum 182 mounted for rotary movement on a stationary stud 183 carried by the panel 15^b, in substantially the plane of the wheel 166. The drum 182 contains a spring 184, the ends of which are connected respectively with the stud 183 and the drum 182, said spring tending at all times to wind the flexible scale 167 upon the drum 182 with just sufficient tension to maintain the scale in flat and straight condition as it passes under the pointer 169. The scale 167 affords a convenient means for indicating at any instant in any desired units, the frequency of the alternating current flow in the oscillatory circuit of which the winding 156 may be a part, depending upon the position at that instant of the contact 171, and it will further be observed that the inductance may be changed continuously and by infinitely small amounts throughout the entire inductance range of the coil 156 and that the same is true whether a secondary winding is used with the winding 156 or not, possible differences in inductance effect due to the secondary winding being compensated for by suitably calibrating the flexible scale 167.

It is obvious that the inductance devices shown and described may be connected in any desired manner, depending upon the other apparatus used and the result to be secured.

In Fig. 21 I show a portion of the top of the casing 10 and panel 23 over the spark gap of the apparatus as a whole, to illustrate the slot 185 preferably formed through the panel 23 to permit the operator to see the spark gap electrodes 101 and 108 and determine when the electrodes are properly adjusted both individually and collectively.

From the above it will appear, where it is desirable in an oscillatory circuit to secure exact adjustment of the frequency of the current flowing in the circuit and to secure a resonant condition of the circuit for any particular frequency within the range of the apparatus, that my variable inductance coil lends itself admirably to the purpose, particularly where the voltages are high, that the inductance changes permitted by my construction, are continuous throughout the entire inductance range of the coil, that coarse steps in the adjustment are eliminated entirely, and that the change in inductance is made smoothly and by infinitesimal amounts throughout the entire inductance range of the coil. It will also appear that my invention is applicable to any type of inductance winding and I do not therefore limit myself in carrying out my invention, to any particular type of inductance winding or coil.

My variable inductance coil is particularly adapted for use in any connection where it is required to change the frequency of current flow over a wide range of frequencies, and where high voltages are involved. For example, with the apparatus above described, the step-up transformer 66 may for the purpose contemplated, have its primary winding supplied with energizing current at 110 volts and with a frequency of 60 cycles per second, common in lighting circuits generally, and its secondary winding may deliver a maximum voltage of 25000 volts at the same frequency. The action of the spark gap, the condenser and the inductance coil connected with the secondary winding of the transformer 66, produces a high frequency current flow through the oscillatory circuit formed by these devices, which may range for example from 750 to 2200 kilocycles per second, depending upon the amount of capacity and inductance contained in the oscillatory circuit, in accordance with well known formulæ for high frequency flow, and the voltage of the current in the inductance winding may be substantially the same as the voltage of the current delivered by the secondary winding of the transformer 66, or somewhat higher, depending upon the apparatus employed. When the high frequency current is supplied to the Tesla transformer, a maximum voltage of, for example, 35000 volts may be generated by the secondary winding of that transformer, and when the Oudin resonator is similarly employed, its secondary winding may develop a voltage as high as 75000 volts. The voltages delivered by the several transformers as above referred to may, of course, be less than the maximum values stated, by decreasing the voltage impressed upon the primary winding of the transformer 66, by operation of the switch 72 to impress on the primary winding but part of the voltage drop across the terminals of the auto-transformer 79. The particular values stated, are given as illustrative only, to emphasize that the apparatus employed is subject to practical limitations to withstand these high voltages, and that many types of variable inductances and variable condensers which are used for tuning high frequency circuits of negligible voltage, for example, one or two volts or less, cannot be used at all for the purpose contemplated by the present invention, since their size would be prohibitive if their windings and parts were sufficiently spaced and insulated to withstand high voltages of the kind under consideration.

While I have shown my invention in the particular embodiments above described, it will be understood that I do not limit myself to these exact constructions as I may employ equivalents known to the art at the time of the filing of this application without departing from the scope of the appended claims.

What I claim is:

1. In an electro-therapeutic machine for producing high frequency electric currents, the combination of a source of high potential alternating current, a spark gap connected across the terminals of said source, a condenser connected with said terminals, and an inductance connected with said terminals to form with said spark gap and said condenser an oscillatory circuit, said inductance comprising a rotary core of insulating material, bearings supporting said core for rotation, a bare winding helically wound on said core with its turns separated from each other, a guide bar supported substantially parallel with said core, a slider on said guide bar, and an electric contact member carried by said slider and engaging said winding, said slider having lateral engagement with said winding moving said slider longitudinally of said guide bar by rotation of said core.

2. In an electro-therapeutic machine for producing high frequency electric currents, the combination of a source of high potential alternating current, a spark gap connected across the terminals of said source, a condenser connected with said terminals, and an inductance connected with said terminals to form with said spark gap and said condenser an oscillatory circuit, said inductance comprising a rotary core of insulating material, bearings supporting said core for rotation, a bare winding helically wound on said core with its turns separated from each other, a guide bar supported substantially parallel with said core, and electric contact mechanism carried by and movable longitudinally of said guide bar and engaging said winding, said contact mechanism having lateral engagement with said winding moving said mechanism longitudinally of said guide bar by rotation of said core.

3. In an electro-therapeutic machine for producing high frequency electric currents, the combination of a source of high potential alternating current, a spark gap connected across the terminals of said source, a condenser connected with said terminals, and an inductance connected with said terminals to form with said spark gap and said condenser an oscillatory circuit, said inductance comprising a rotary core of insulating material, bearings supporting said core for rotation, a bare winding helically wound on said core with its turns separated from each other, a guide bar supported substantially parallel with said core, and electric contact mechanism carried by and movable longitu-

dinally of said guide bar and engaging said winding, said contact mechanism having lateral engagement with said winding moving said mechanism longitudinally of said guide bar by rotation of said core, said bearings comprising posts of insulating material supporting said guide bar.

4. In an electro-therapeutic machine for producing high frequency electric currents, the combination of a source of high potential alternating current, a spark gap connected across the terminals of said source, a condenser connected with said terminals, and an inductance connected with said terminals to form with said spark gap and said condenser an oscillatory circuit, said inductance comprising a rotary core of insulating material, bearings supporting said core for rotation, a bare winding helically wound on said core with its turns separated from each other, a guide bar supported substantially parallel with said core, a slider on said guide bar, an electric contact member carried by said slider and engaging said winding, said slider having lateral engagement with said winding moving said slider longitudinally of said guide bar by rotation of said core, a pointer carried by said slider, and a scale cooperating with said pointer and indicating the frequency of the alternating current in said oscillatory circuit for any position of said core.

5. In an electro-therapeutic machine for producing high frequency electric currents, the combination of a source of high potential alternating current, a spark gap connected across the terminals of said source, a condenser connected with said terminals, and an inductance connected with said terminals to form with said spark gap and said condenser an oscillatory circuit, said inductance comprising a rotary core of insulating material, bearings supporting said core for rotation, a bare winding helically wound on said core with its turns separated from each other, a guide bar supported substantially parallel with said core, electric contact mechanism carried by and movable longitudinally of said guide bar and engaging said winding, said contact mechanism having lateral engagement with said winding moving said mechanism longitudinally of said guide bar by rotation of said core, a pointer carried by said contact mechanism, and a scale cooperating with said pointer and indicating the frequency of the alternating current in said oscillatory circuit for any position of said core.

6. In an electro-therapeutic machine for producing high frequency electric currents, the combination of a source of high potential alternating current, a spark gap connected across the terminals of said source, a condenser connected with said terminals, an inductance connected with said terminals to form with said spark gap and said condenser an oscillatory circuit, said inductance comprising a rotary core of insulating material, bearings supporting said core for rotation, a bare winding helically wound on said core with its turns separated from each other, a guide bar supported substantially parallel with said core, a slider on said guide bar, and an electric contact member carried by said slider and engaging said winding, said slider having lateral engagement with said winding moving said slider longitudinally of said guide bar by rotation of said core, and supply terminals of a patient's circuit connected with one end of said winding and with said contact member.

7. In an electro-therapeutic machine for producing high frequency electric currents, the combination of a source of high potential alternating current, a spark gap connected across the terminals of said source, a condenser connected with said terminals, an inductance connected with said terminals to form with said spark gap and said condenser an oscillatory circuit, said inductance comprising a rotary core of insulating material, bearings supporting said core for rotation, a bare winding helically wound on said core with its turns separated from each other, a guide bar supported substantially parallel with said core, and electric contact mechanism carried by and movable longitudinally of said guide bar and engaging said winding, said contact mechanism having lateral engagement with said winding moving said mechanism longitudinally of said guide bar by rotation of said core, and supply terminals of a patient's circuit connected with one end of said winding and with said contact mechanism.

8. In an electro-therapeutic machine, the combination of a source of alternating current, a spark gap, a condenser, and an inductance connected to constitute an oscillatory circuit, said inductance comprising a rotary core of insulating material, bearings supporting said core for rotation, a bare winding helically wound on said core with its turns separated from each other, a guide bar supported substantially parallel with said core, a slider on said guide bar, and an electric contact member carried by said slider and engaging said winding, said slider having lateral engagement with said winding moving said slider longitudinally of said guide bar by rotation of said core.

9. In an electro-therapeutic machine, the combination of a source of alternating current, a spark gap, a condenser, and an inductance connected to constitute an oscillatory circuit, said inductance comprising a rotary core of insulating material, bearings supporting said core for rotation, a bare winding helically wound on said core with its turns separated from each other, a guide

bar supported substantially parallel with said core, and electric contact mechanism carried by and movable longitudinally of said guide bar and engaging said winding, said contact mechanism having lateral engagement with said winding moving said mechanism longitudinally of said guide bar by rotation of said core.

10. In an electro-therapeutic machine, the combination of a source of alternating current, a spark gap, a condenser, and an inductance connected to constitute an oscillatory circuit, said inductance comprising a rotary core of insulating material, bearings supporting said core for rotation, a bare winding helically wound on said core with its turns separated from each other, a guide bar supported substantially parallel with said core, and electric contact mechanism carried by and movable longitudinally of said guide bar and engaging said winding, said contact mechanism having lateral engagement with said winding moving said mechanism longitudinally of said guide bar by rotation of said core, said bearings comprising posts of insulating material supporting said guide bar.

11. In an electro-therapeutic machine, the combination of a source of alternating current, a spark gap, a condenser, and an inductance connected to constitute an oscillatory circuit, said inductance comprising a rotary core of insulating material, bearings supporting said core for rotation, a bare winding helically wound on said core with its turns separated from each other, a guide bar supported substantially parallel with said core, electric contact mechanism carried by and movable longitudinally of said guide bar and engaging said winding, said contact mechanism having lateral engagement with said winding moving said mechanism longitudinally of said guide bar by rotation of said core, a pointer carried by said contact mechanism, and a scale cooperating with said pointer and indicating the frequency of the alternating current in said oscillatory circuit for any position of said core.

12. In an electro-therapeutic machine, the combination of a source of alternating current, a spark gap, a condenser, and an inductance connected to constitute an oscillatory circuit, said inductance comprising a rotary core of insulating material, bearings supporting said core for rotation, a bare winding helically wound on said core with its turns separated from each other, a guide bar supported substantially parallel with said core, and electric contact mechanism carried by and movable longitudinally of said guide bar and engaging said winding, said contact mechanism having lateral engagement with said winding moving said mechanism longitudinally of said guide bar by rotation of said core, and supply terminals of a patient's circuit connected with one end of said winding and with said contact mechanism.

13. In an electro-therapeutic machine, the combination of a spark gap, a condenser, and an inductance connected to constitute an oscillatory circuit, said inductance comprising a rotary core of insulating material, bearings supporting said core for rotation, a bare winding helically wound on said core with its turns separated from each other, and electric contact mechanism mounted for relative movement laterally of and engaging said winding, said contact mechanism having lateral engagement with said winding effecting relative movement of said mechanism laterally of said winding.

14. In an electro-therapeutic machine, the combination of a spark gap, a condenser, and an inductance connected to constitute an oscillatory circuit, said inductance comprising a rotary core of insulating material, bearings supporting said core for rotation, a bare winding helically wound on said core with its turns separated from each other, electric contact mechanism mounted for relative movement laterally of and engaging said winding, and indicating devices actuated by said relative lateral movement indicating the frequency of the current in said oscillatory circuit for any position of said contact mechanism on said winding.

15. In an electro-therapeutic machine, the combination of a spark gap, a condenser, and an inductance connected to constitute an oscillatory circuit, said inductance comprising a rotary core of insulating material, bearings supporting said core for rotation, a bare winding helically wound on said core with its turns separated from each other, electric contact mechanism mounted for relative movement laterally of and engaging said winding, a pointer actuated by said relative movement, and a scale cooperating with said pointer and showing the frequency of the current in said oscillatory circuit for any position of said contact mechanism on said winding.

16. In an electro-therapeutic machine, the combination of a spark gap, a condenser, and an inductance connected to constitute an oscillatory circuit, said inductance comprising a rotary core of insulating material, bearings supporting said core for rotation, a bare winding helically wound on said core with its turns separated from each other, electric contact mechanism mounted for relative movement laterally of and engaging said winding, and supply terminals of a patient's circuit connected with said winding and said contact mechanism.

17. In an electro-therapeutic machine, the combination of a spark-gap, a condenser, and an inductance connected to constitute an oscillatory circuit, said inductance comprising an inductive winding, electric contact mecha-

nism engaging the conductor of said winding with sliding contact longitudinally of said conductor, and means supporting said winding and said contact mechanism for relative movement in a first direction and permitting relative movement between said winding and said contact mechanism in a second direction to maintain said contact mechanism in said sliding contact with said conductor.

18. In an electro-therapeutic machine, the combination of a spark-gap, a condenser, and an inductance connected to constitute an oscillatory circuit, said inductance comprising an inductive winding, electric contact mechanism engaging the conductor of said winding with sliding contact longitudinally of said conductor, means supporting said winding and said contact mechanism for relative movement in a first direction and permitting relative movement between said winding and said contact mechanism in a second direction to maintain said contact mechanism in said sliding contact with said conductor, and devices operated by said relative movements indicating in desired units the inductance effect of said inductive winding.

19. In an electro-therapeutic machine, the combination of a spark-gap, a condenser, and an inductance connected to constitute an oscillatory circuit, said inductance comprising an inductive winding, electric contact mechanism engaging the conductor of said winding with sliding contact longitudinally of said conductor, and means supporting said winding and said contact mechanism for relative movement in a first direction and permitting relative movement between said winding and said contact mechanism in a second direction to maintain said contact mechanism in said sliding contact with said conductor, and terminals of a patient's circuit connected with said oscillatory circuit.

20. In an electro-therapeutic machine, the combination of a spark-gap, a condenser, and an inductance connected to constitute an oscillatory circuit, said inductance comprising an inductive winding, electric contact mechanism engaging the conductor of said winding with sliding contact longitudinally of said conductor, means supporting said winding and said contact mechanism for relative movement in a first direction and permitting relative movement between said winding and said contact mechanism in a second direction to maintain said contact mechanism in said sliding contact with said conductor, and devices operated by said relative movements indicating in desired units the inductance effect of said inductive winding, and terminals of a patient's circuit connected with said oscillatory circuit.

In witness whereof, I hereunto subscribe my name this 17th day of September, A. D. 1928.

HERMAN P. PULLWITT.

March 3, 1931. H. P. MacLAGAN **1,794,914**

SPARK GAP CONSTRUCTION

Filed July 2, 1927

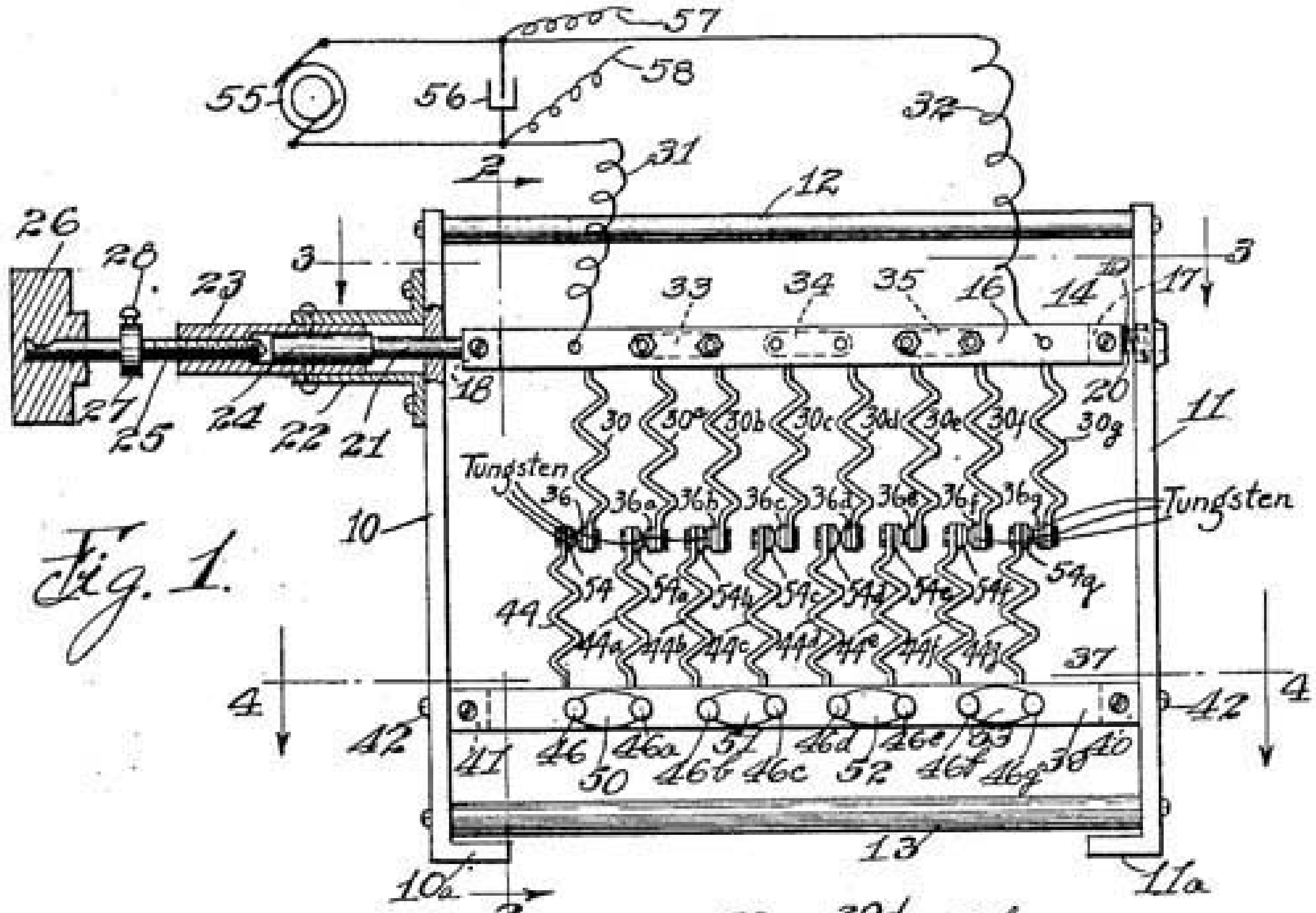

Fig. 1.

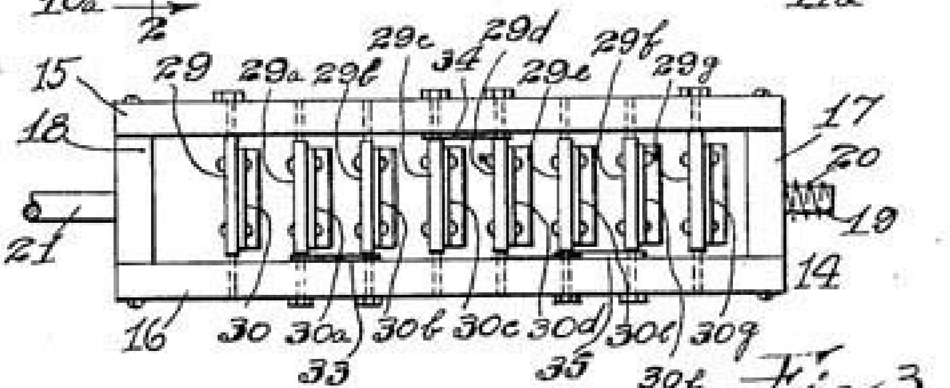

Fig. 3.

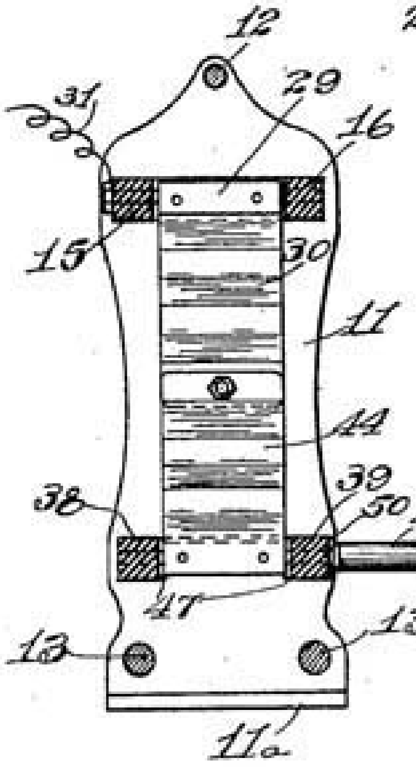

Fig. 2.

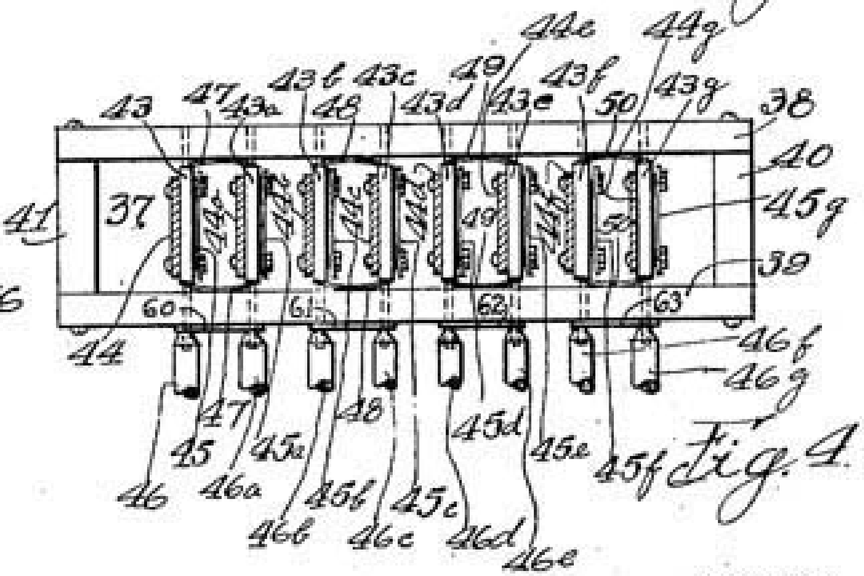

Fig. 4.

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UNITED STATES PATENT OFFICE

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SPARK-GAP CONSTRUCTION

Application filed July 2, 1927. Serial No. 203,074.

My invention relates to an improved construction of spark-gap for producing high frequency alternating current discharge for electro-therapeutic and other purposes, for example deep heating of the tissues of the body.

My invention consists essentially of a plurality of pairs of spark-gap contacts, one of each pair being mounted on an insulating framework by which all of these contacts so mounted may be moved simultaneously relatively to the other contacts of the several pairs to produce a plurality of spark-gaps, the other contacts of the several pairs being mounted on a second insulating framework and each provided with an adjusting handle for moving the corresponding contact relatively to the other contact of the same pair. By my construction I further provide devices for moving the first framework referred to and all of the contacts carried by it, so that similar spark-gaps are produced simultaneously between the contacts of the several pairs. I further provide the device with electrical connections arranged to connect the several spark-gaps in series with each other, since I find that this arrangement is more effective in producing high frequency discharge than where a single gap is used having a length equal to the sum of the several gaps connected in series with each other. By my construction I mount the several gap contacts on substantial metal plates affording large areas for heat radiation, to the end that the parts of the device may not be overheated by the sparking action.

My invention will best be understood by reference to the accompanying drawings, showing a preferred embodiment thereof in which

Fig. 1 shows my construction in side elevation and partially in sectional view to show the operating mechanism,

Fig. 2 is a vertical sectional view of the parts shown in Fig. 1 taken along the line 2—2,

Fig. 3 shows in plan view the upper and movable contact supporting framework, and

Fig. 4 shows in plan view the lower and fixed contact supporting framework.

Similar numerals refer to similar parts throughout the several views.

As shown in the drawings my device consists of end plates 10 and 11, preferably of metal held in separated relation by rods 12 and 13 of suitable insulating material, preferably having a high insulating value and resisting surface creepage as far as possible, which rods may be secured in any desired manner at their ends, for example by screws, to the end plates 10 and 11. The end plates 10 and 11 may be provided with feet 10*a* and 11*a* at their lower edges to afford a convenient support for the device and to facilitate mounting it as and where desired.

Between the upper portions of the end plates 10 and 11, I support a first framework 14 which, as more clearly indicated in Fig. 3, consists of side bars 15 and 16 of insulating material, for example lava, connected at their ends in suitable manner, for example by screws, with metal end bars 17 and 18. The bar 17 has projecting from its mid portion a metal rod 19 to enter a corresponding aperture in the end plate 11, which rod 19 is surrounded by a spring 20 held in compression between the bar 17 and the end plate 11. The mid portion of the bar 18 has projecting therefrom a metal rod 21, extending through a corresponding aperture in the end plate 10 and into a metal housing 22 secured to the outer surface of the end plate 10. The housing 22 is provided with a bore for supporting a bushing 23 of insulating material substantially in axial alignment with the axis of the rod 21, which bushing is held in place in the housing 22 in any convenient manner, for example by screws as indicated. The inner end of the bore in the bushing 23 is of a size to receive with a free sliding fit a rod 24 of insulating material which rests against the end of the rod 21. The outer portion of the bore in the bushing 23 is threaded to receive a screw 25, the inner end of which may engage the outer end of the rod 24. The screw 25 is provided at its outer end with an operating head 26 by which the screw may be turned to move the framework 14 to the right, and when the screw 25 is turned in the opposite direction by means of the head 26, the spring

20 serves to move the framework 14 to the left. In this manner any desired position may be given the framework 14 and the contacts carried thereby. A collar 27 is preferably provided on the screw 25 near its outer end, which is provided with a set screw 28 for securing the collar at any desired point on the screw 25 to limit motion to the right of the framework 14 and thus secure any desired amount of separation of the contacts of the several spark-gaps, so that when the collar 27 is given a desired adjustment, spark-gaps of the desired length will be secured by turning the screw 25 as far as it will go against the action of the spring 20.

As shown in Fig. 3, the bars 15 and 16 are provided with aligned holes for receiving the ends of metal bars 29, 29*a*, 29*b*, 29*c*, 29*d*, 29*e*, 29*f* and 29*g* to which bars the upper end of plates 30, 30*a*, 30*b*, 30*c*, 30*d*, 30*e*, 30*f* and 30*g* are respectively secured in any desired manner, for example by riveting. The bars 29 to 29*g* are rigidly held in the framework 14 so that the plates 30 to 30*g* cannot readily be moved relatively to the framework, by threading the outer ends of the supporting projections of the bars 29 to 29*g* and screwing nuts tightly on said threaded ends, but one nut being used by each of the bars. The arrangement further provides that the bar 29 is rigidly secured to the insulating bar 15, that the bars 29*a* and 29*b* are rigidly secured to the insulating bar 16, that the bars 29*c* and 29*d* are rigidly secured to the insulating bar 15, that the bars 29*e* and 29*f* are rigidly secured to the insulating bar 16, and that the bar 29*g* is secured to the insulating bar 15. As indicated in Fig. 1, the nuts on the ends of the bars 29 and 29*g* form convenient means for making electrical contact with said bars by the terminal wires 31 and 32 of the device. The bars 29*a* and 29*b* are electrically connected by a metal plate 33 inside of the insulating bar 16 held in firm engagement with the bars 29*a* and 29*b* by the nuts on the ends of said bars; the bars 29*c* and 29*d* are similarly connected electrically by a metal plate 34 inside of the insulating bar 15; and the bars 29*e* and 29*f* are similarly electrically connected by a metal plate 35 inside of the insulating bar 16. The end portions of the bars 29 to 29*g* are preferably shouldered to facilitate clamping the bars and connecting plates tightly against the insulating bars 15 and 16 in the manner described. The distance between the shouldered portions of each of the bars 29 to 29*g* is preferably somewhat less than the distance between the inner surfaces of the insulating bars 15 and 16 so that no undue strains are exerted on the framework 14 by the heating of the bars 29 to 29*g* and plates 30 to 30*g*, the end extensions from the bars 29 to 29*g* not provided with clamping nuts being preferably a free sliding fit in the holes provided to receive them.

As indicated in Figs. 1 and 2, the plates 30 to 30*g* are provided on the left hand side of the mid portions of their lower ends, with contacts 36, 36*a*, 36*b*, 36*c*, 36*d*, 36*e*, 36*f* and 36*g* respectively, which are preferably of tungsten and held in place by having portions of reduced diameter extending through the corresponding plates and threaded to receive nuts as indicated.

Between the lower portions of the end plates 10 and 11, a second framework 37 is diposed, of similar construction to the framework 14 excepting as to the manner of mounting it between the end plates 10 and 11. As shown in Fig. 4, the framework 37 consists of insulating side bars 38 and 39 and metal end bars 40 and 41, the framework being held in place between the end plates 10 and 11 by suitable screws 42, so that no movement of the framework is possible relatively to the end plates. The bars 38 and 39 are provided with aligned holes for receiving the shouldered ends of bars 43, 43*a*, 43*b*, 43*c*, 43*d*, 43*e*, 43*f* and 43*g* and to these bars the lower edges of contact plates 44, 44*a*, 44*b*, 44*c*, 44*d*, 44*e*, 44*f* and 44*g* are respectively secured, preferably by small screws and nuts as indicated. These screws are preferably fitted in the contact plates and their supporting bars to permit a small amount of play of the contact plates relatively to the supporting bars and to hold the contact plates in place on the bars with a slightly yielding engagement. Thin flat plates of suitable spring metal 45, 45*a*, 45*b*, 45*c*, 45*d*, 45*e*, 45*f* and 45*g* respectively are located on the bars 43 to 43*g*, one of said spring plates being disposed between each of said bars and the pair of nuts used with it to hold the corresponding contact plate in place on it.

The bars 43 to 43*g* are preferably shouldered at their ends as described for the bars 29 to 29*g*, and the distance between their shouldered end is somewhat less than the distance between the inner surfaces of the insulating bars 38 and 39 for the purpose above described for the bars 29 to 29*g*. The shouldered extensions of all of the bars 43 to 43*g* extend at one end through the insulating bar 39 and have rigidly secured to their projecting ends respectively, handles 46 to 46*g* inclusive, of insulating material, for independently turning the bars 43 to 43*g* and the contact plates carried thereby, relatively to the framework 37.

The bars 43 and 43*a* are electrically connected by thin plate 47 of spring metal between their end shoulders and the inner surfaces of the insulating bars 38 and 39; the bars 43*b* and 43*c* are similarly connected by similar plates 48; the bars 43*d* and 43*e* are similarly connected by similar plates 49; and the bars 43*f* and 43*g* are similarly connected by similar plates 50. Plates 60, 61, 62, and 63, similar to the plates 47, 48, 49 and 50 are disposed on the extensions of the corresponding ones of the bars 43 to 43*g*, between the handles 46 to 46*g* and the outer surface of the insulating bar 39.

As indicated in Figs. 1 and 2, the plates 44 to 44*g*, carry at their mid-portions near their upper edges, contacts 54 to 54*g* similar to the contacts 36 to 36*g* above described and similarly secured to the corresponding supporting plates, these contacts being in alignment respectively with the contacts 36 to 36*g*, to cooperate respectively with the contacts 36 to 36*g* to form the several spark-gaps. The cooperating faces of the contacts are preferably crowned to insure proper cooperation for different conditions of adjustment.

In using the device, I find it desirable to turn the screw 25 inwardly as far it will go against the action of the spring 20, to then move the contacts 54 to 54*g* against the contacts 36 to 36*g* by rotation of the handles 46 to 46*g*, to then turn the screw 25 in a direction to permit movement of the frame 14 by the action of the spring 20 as far as it will go, and then to turn the screw 25 to move the contacts 36 to 36*g* away from contacts 54 to 54*g* to give the desired separation between the contacts. The spring mounting of the contacts 54 to 54*g* insures their making proper contact with the corresponding rigid contacts and the mode of procedure described insures that all of the spark-gaps shall be of substantially the same length.

In Fig. 1 I illustrate diagrammatically the connection of the wires 31 and 32 to a source of high tension alternating current 55 and the connection of a condenser 56 to said wires. The combined action of the condenser 56 and the spark-gaps of the device is such that when the current is caused to jump the spark-gaps by the impressed electromotive force, a high frequency alternating current is produced due to oscillation of charge and discharge in the condenser 56. Current may be taken from this high frequency circuit for desired application by wires 57 and 58.

From the above it will appear that desired degrees of separation of the contacts may be secured readily by my device, that the construction is substantial and will not readily get out of order and that the heat developed at the spark-gaps is effectively disposed of by the large area plates carrying the spark-gap contacts; also that substantially the same length of gap may be established at any spark-gap as at the other spark-gaps and that desired lengths of gaps may be definitely secured in any particular case by a corresponding setting of the stop collar 27 on the screw 25.

While the plates 30—30*g* and 44—44*g* may be made of any convenient size and shape to meet the requirements of any particular case, I find it preferable to corrugate them as shown in Fig. 1 to the end that they may have a maximum of cooling surface within the limited dimensions of the device as a whole, required to make it convenient to use and readily portable.

Several most important advantages result from making and mounting the gap contacts as described. In the first place, the crowned ends of the contacts insure that at each gap the spark will be maintained for any particular adjustment, between the same two points on the two contacts of the gap, instead of moving about on the sparking surfaces as occurs when they are plane surfaces; this prevents sparking at the edges of the ends of the contacts and avoids the edge pitting that occurs when edge sparking takes place due to the concentration of the current flow at the edges of the contacts. Again, the crowned sparking surfaces provide that the sparking will occur at the mid-portion of the crowned surfaces, regardless of the degree of separation of the contacts, it being borne in mind that each gap permitted by this device is but a part of an inch; in this way undue heating and pitting of the contacts is avoided. Again, the contacts are secured in fixed relation, to their mounting plates, which prevents any displacement of the contacts of any pair, relatively to each other, around the axes of the contacts, and maintains a constant and uniform sparking condition and relation at any pair of contacts, for any particular adjustment whenever the latter is used, even though the contacts may be used in other positions between uses of that particular adjustment.

The described manner of mounting one contact of each pair for independent movement, permits the fixed relative relation referred to, between the contacts of each pair, and at the same time permits independent movement of one of the contacts bodily towards and from the other contact of the pair, always maintaining the sparking points at the mid-portions of the crowned surfaces; it also permits locating the adjusting devices involved in said independent movement, at a considerable distance from the contacts, out of the highly heated zone resulting from the sparking action, which could not be done were the contacts movable relatively to their mounting plates for purposes of individual adjustment.

The features of construction just referred to not only greatly facilitate the operation of the device, but they also combine to insure permanence, dependability and uniformity of operation to a high degree.

While I have shown my invention in the particular embodiment above described, it will be understood that I do not limit myself to this exact construction as I may employ equivalents known to the art at the time of the filing of this application without departing from the scope of the appended claims.

What I claim is:

1. In a spark-gap, the combination of a support, a first insulating framework carried by said support and movable relatively thereto, first spark-gap contacts carried by said framework, a second insulating framework carried by said support and fixed relatively thereto, second spark-gap contacts carried by said second framework and each cooperating with one of said first contacts to form a spark-gap, devices for moving said first framework to form as many spark-gaps of desired length as there are of said first contacts, and metal conductors connecting said spark-gaps in series with each other, said second contacts being individually movable relatively to said second framework to permit independently moving said second contacts into engagement with corresponding ones of said first contacts for different positions of said first framework.

2. In a spark-gap, the combination of a support, a first insulating framework carried by said support and movable relatively thereto, first spark-gap contacts carried by said framework, a second insulating framework carried by said support and fixed relatively thereto, second spark-gap contacts carried by said second framework and each cooperating with one of said first contacts to form a spark-gap, devices for moving said first framework to form as many spark-gaps of desired length as there are of said first contacts, metal conductors connecting said spark-gaps in series with each other, shafts mounted for turning movement in said second framework and each carrying eccentrically one of said second contacts, and a handle of insulating material secured to each of said shafts.

3. In a spark-gap, the combination of a support, a first insulating framework carried by said support and movable relatively thereto, first spark-gap contacts carried by said framework, a second insulating framework carried by said support and fixed relatively thereto, second spark-gap contacts carried by said second framework and each cooperating with one of said first contacts to form a spark-gap, devices for moving said first framework to form as many spark-gaps of desired length as there are of said first contacts, metal conductors connecting said spark-gaps in series with each other, and a metal plate having large radiating surface supporting each contact, said contacts comprising blocks of tungsten secured to said plates by screws and nuts for replacement purposes and having crowned gap surfaces.

4. In a spark-gap, the combination of a support, a first insulating framework carried by said support and movable relatively thereto, first spark-gap contacts carried by said framework, a second insulating framework carried by said support and fixed relatively thereto, second spark-gap contacts carried by said second framework and each cooperating with one of said first contacts to form a spark-gap, devices for moving said first framework to form as many spark-gaps of desired length as there are of said first contacts, metal conductors connecting said spark-gaps in series with each other, a metal plate having large radiating surface eccentrically supporting each contact, shafts mounted for turning movement in said second framework and each secured to one of said metal plates, and a handle of insulating material secured to each of said shafts.

5. In a spark-gap, the combination of a support, a first insulating framework carried by said support and movable relatively thereto, first spark-gap contacts carried by said framework, a second insulating framework carried by said support and fixed relatively thereto, second spark-gap contacts carried by said second framework and each cooperating with one of said first contacts to form a spark-gap, devices for moving said first framework to form as many spark-gaps of desired length as there are of said first contacts, metal conductors connecting said spark-gaps in series with each other, a metal plate having large radiating surface supporting each contact, shafts mounted for turning movement in said second framework and each secured to one of said metal plates, a handle of insulating material secured to each of said shafts, and a yielding device connecting each of said shafts with the plate carried thereby.

6. In a spark-gap, the combination of a support, a first insulating framework carried by said support and movable relatively thereto, first spark-gap contacts carried by said framework, a second insulating framework carried by said support and fixed relatively thereto, second spark-gap contacts carried by said second framework and each cooperating with one of said first contacts to form a spark-gap, devices for moving said first framework to form as many spark-gaps of desired length as there are of said first contacts, and metal conductors connecting said spark-gaps in series with each other, said devices comprising a sliding insulating rod engaging said first framework, a metal screw engaging said insulating rod, a handle secured to said screw, and a housing extending from said support and having a clearance opening for said insulating rod and carrying screw threads engaging said screw.

7. In spark-gap, the combination of a support, a first insulating framework carried by said support and movable relatively thereto, first spark-gap contacts carried by said framework, a second insulating framework carried by said support and fixed relatively thereto, second spark-gap contacts carried by

said second framework and each cooperating with one of said first contacts to form a spark-gap, devices for moving said first framework to form as many spark-gaps of desired length as there are of said first contacts, and metal conductors connecting said spark-gaps in series with each other, said devices comprising a sliding insulating rod engaging said first framework, a metal screw engaging said insulating rod, a handle secured to said screw, a housing extending from said support, and a sleeve of insulating material extending from said housing and having a bore loosely containing said insulating rod and screw threads engaging said screw.

8. In a spark-gap, the combination of a support, a first insulating framework carried by said support and movable relatively thereto, first spark-gap contacts carried by said framework, a second insulating framework carried by said support and fixed relatively thereto, second spark-gap contacts carried by said second framework and each cooperating with one of said first contacts to form a spark-gap, devices for moving said first framework to form as many spark-gaps of desired length as there are of said first contacts, and metal conductors connecting said spark-gaps in series with each other, said devices comprising a sliding insulating rod engaging said first framework, a metal screw engaging said insulating rod, a handle secured to said screw, a housing extending from said support and having a clearance opening for said insulating rod and carrying screw threads engaging said screw, and a spring tending to oppose the action of said screw.

9. In a spark-gap, the combination of a support, a first insulating framework carried by said support and movable relatively thereto, first spark-gap contacts carried by said framework, a second insulating framework carried by said support and fixed relatively thereto, second spark-gap contacts carried by said second framework and each cooperating with one of said first contacts to form a spark-gap, devices for moving said first framework to form as many spark-gaps of desired length as there are of said first contacts, and metal conductors connecting said spark-gaps in series with each other, said devices comprising a sliding insulating rod engaging said first framework, a metal screw engaging said insulating rod, a handle secured to said screw, a housing extending from said support, a sleeve of insulating material extending from said housing and having a bore loosely containing said insulating rod and screw threads engaging said screw, and a spring tending to oppose the action of said screw.

10. In a spark-gap, the combination of a support, a first insulating framework carried by said support and movable relatively thereto, first spark-gap contacts carried by said framework, a second insulating framework carried by said support and fixed relatively thereto, second spark-gap contacts carried by said second framework and each cooperating with one of said first contacts to form a spark-gap, devices for moving said first framework to form as many spark-gaps of desired length as there are of said first contacts, metal conductors connecting said spark-gaps in series with each other, and a corrugated metal plate having large radiating surface supporting each contact.

In witness whereof, I hereunto subscribe my name this 24th day of June, A. D. 1927.

HECTOR P. MacLAGAN.

July 25, 1933. L. L. DOANE **1,919,543**

MEANS FOR EFFECTING THE BLOODLESS REMOVAL OF DISEASED TISSUE

Filed March 29, 1930

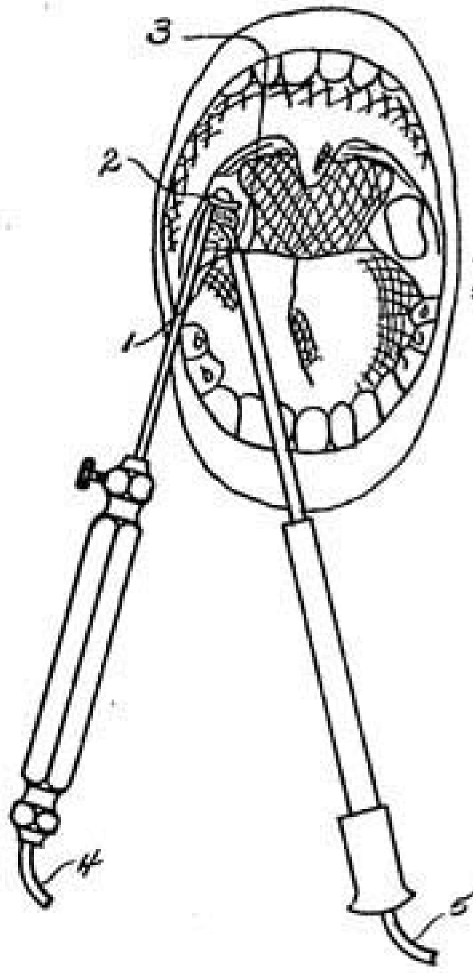


Fig. 1.

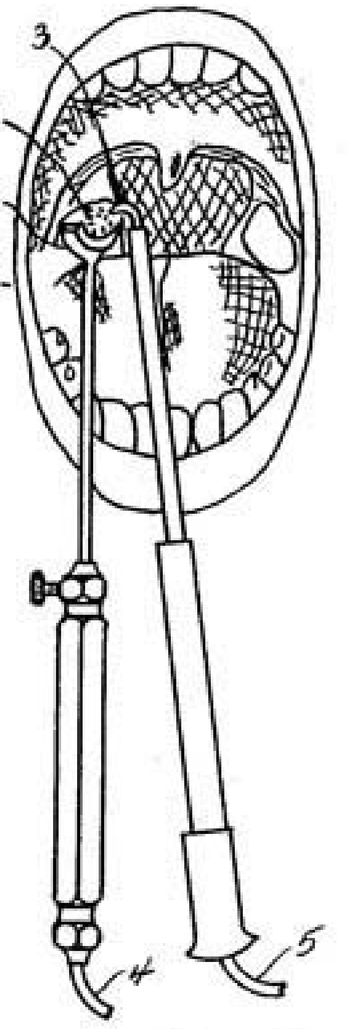


Fig. 2.

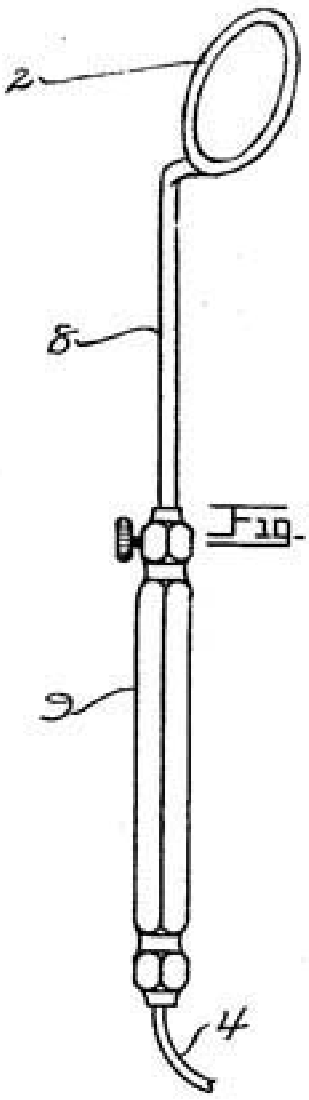


Fig. 3.

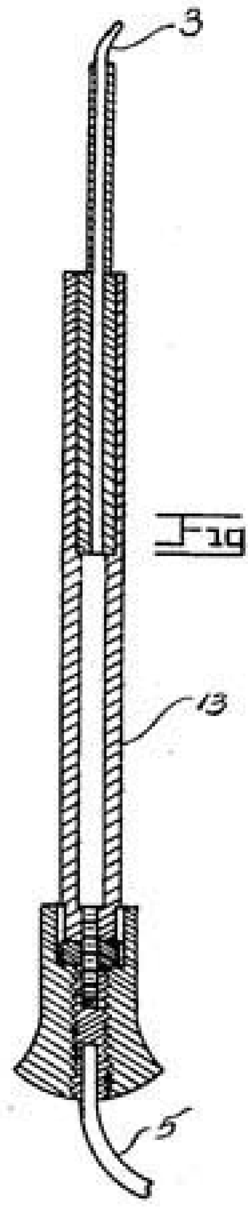


Fig. 5.

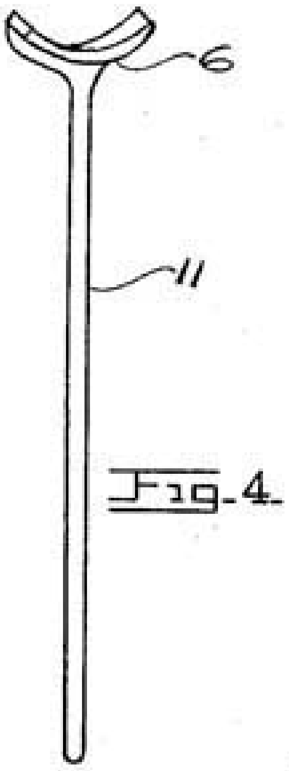


Fig. 4.

INVENTOR.
LEON LEO DOANE
BY Albert C. Bell
ATTORNEY

Patented July 25, 1933

1,919,543

UNITED STATES PATENT OFFICE

LEON LEO DOANE, OF BUTLER, PENNSYLVANIA, ASSIGNOR TO McINTOSH ELECTRICAL CORPORATION, OF CHICAGO, ILLINOIS, A CORPORATION OF DELAWARE

MEANS FOR EFFECTING THE BLOODLESS REMOVAL OF DISEASED TISSUE

Application filed March 29, 1930. Serial No. 439,880.

My invention consists of an improved method of removal of tonsillar tissue and also of an improved means or instruments for carrying the method into effect.

The prime object of the invention is to remove diseased tonsillar tissue in a bloodless manner by means of an electric current and to restrict the action of the electric current to the diseased area.

A further object of the invention is to provide suitable electrodes to localize the current to the desired tonsil area.

Other objects of the invention will appear from the following description which is directed to the preferred embodiment of the invention as shown in the drawing and hereafter described, the novel features being more particularly set forth in the appended claims.

In the drawing,

Fig. 1 is a view of the open human mouth, illustrating an application of my method by means of a ring electrode,

Fig. 2 is a similar view showing the use of a crutch type of electrode,

Fig. 3 is a perspective view of a ring type electrode mounted in a handle,

Fig. 4 is a perspective view of a crutch type of electrode removed from the handle, and

Fig. 5 is a longitudinal sectional view through the needle point or active electrode mounted in an insulated handle.

Similar numerals refer to similar parts throughout the several views.

The reference character 1, in Fig. 1, indicates a tonsil, the electrodes 2 and 3 being adjusted to the tonsil, to conduct to it an electric current of high voltage and high frequency, preferably of the d'Arsonval type, by means of the conductors 4 and 5 connected with the electrodes. In the practice of the improved method, the electrode 2 in Fig. 1 and the electrode 6 in Fig. 2 are known as the indifferent electrodes and are utilized to restrict the electric current to a desired area. The electrode 3 shown in Fig. 1 and in Fig. 2, is known as the active electrode. Due to the smallness of the point of the active electrode relatively to the surface of the indifferent electrode applied to the tonsil, and the fact that the same amount of current flows through the active electrode as flows through the indifferent electrode, the density of the current flow concentrated at the point of the active electrode causes the tonsillar tissue to coagulate at the point of application of the active electrode, the electric current flow is limited to the area between the active and the indifferent electrode, and the density of the current flow at the indifferent electrode is so small that undesirable effects at the indifferent electrode may readily be avoided.

After the coagulation or destruction of the tonsillar tissue is complete, the coagulated tissue may be left in situ or removed by any suitable instrument.

According to the method heretofore employed for the coagulation of tissue of the tonsils, it has been customary to use a large indifferent electrode, consisting either of a handle held in the hand of the patient, or a large sheet metal plate placed upon the abdomen or back of the patient, connected with a source of electric current of high voltage and high frequency, and an active electrode, consisting of a needle attached to an insulated handle and connected with the source of current, the needle being inserted in that portion of the tonsil where it is desired to produce coagulation of the tissue. The employment of this method causes the current to flow through the tonsillar tissue and through the bases of the pillars and deeper structures of the throat, causing an engorgement of the blood vessels of this region, which may result in edema of the pillars and adjacent tissues with much discomfort to the patient and the possibility of a secondary hemorrhage later.

By the improved method of my invention, instead of applying an indifferent electrode to the hands, the back or abdomen of the patient, necessitating a strong current to overcome the resistance of the body, the two electrodes are placed near each other, with little intervening tissue; hence, a minimum resistance exists, and a mild current suffices. Selection is made from various forms of indifferent electrodes of the one best adapted to the structure of the tonsils to be treated. This electrode is attached to the metal handle 9 in Fig. 3 and connected to a source of electric current of high voltage and high frequency, and the active electrode 3 in Fig. 1 is connected to a second terminal of the same source of electric current.

By means of the indifferent electrode, the tonsil is engaged at its base and the pillars are retracted from the tonsil; then the active electrode is inserted into the portion desired to be treated and by means of a suitable switch connected in the electric circuit, the current is turned on for a period sufficient to produce coagulation, after which the current is turned off.

Employment either of the ring or crutch type of electrode as the indifferent electrode in close proximity to the active electrode, causes a rapid coagulation of the diseased tissue.

Figs. 3, 4 and 5 show different forms of metal electrodes which may be used to carry out my improved method of removing tonsillar tissue. In Fig. 3, one form of the ring type of indifferent electrode is shown at 2, having a shank 8, mounted in a metal handle 9, connected with a current carrying cord 4. In Fig. 4 one form of the crutch type of indifferent electrode is shown at 6, having a shank 11. In Fig. 5 a needle type or active electrode 3 is shown provided with an insulated handle 13, and connected with a current carrying cord 5.

It will be understood that the electrodes shown and described in connection with Figs. 3, 4 and 5 are illustrative of particular forms of the several types shown, and that many other forms may be employed without departing from my invention. For example, with the ring type of electrode illustrated in Fig. 3, any desired size and shape of ring may be employed, having any desired inclination and relation to the shank of the electrode. Similarly, with the crutch type of electrode illustrated in Fig. 4, any desired shape and proportions may be employed, having any desired relation to the shank of the electrode. For convenience, the shanks of the indifferent electrodes are of a size to be held by the same handle 9, although each may be provided with its own handle if preferred.

Referring particularly to Figs. 3 and 4, the contact area of electrode 2 in Fig. 3 and of electrode 6 in Fig. 4, is extremely large in comparison with the contact area of the needle point 3 of the active electrode in Fig. 5. The ring 2 shown in Fig. 3 and its shank 8 are of metal, the ring being of proper size to closely fit the tonsil being treated. The crutch type of indifferent electrode 6, shown in Fig. 4, is curved to fit the curvature of the tonsil and is used when it is difficult to place the ring type electrode over the tonsil, the electrode 6 and shank 11 being of metal. All of the shanks of the indifferent electrodes are preferably made to interchangeably fit the metal handle 9, which may have the electric cord 4 permanently connected with it.

The active or needle point electrode 3 shown in Fig. 5, is completely insulated by the insulation of the handle 13, nearly to the point of the needle, leaving, for example, about one-quarter of an inch of the point of the needle exposed, and the current conducting cord 5 may be permanently connected with the shank of the needle in the handle 13.

In the use of these electrodes and employing the method described, the removal of tonsillar tissue is accomplished as follows:

The electrodes are connected by means of the current carrying conducting cords to a suitable supply of high frequency current; the indifferent electrode is then applied to the base of the tonsil, retracting intervening membranes; the active electrode is then inserted into the diseased tissue of the tonsil in proximity to the indifferent electrode, the metal and insulated handles being held by the operator; the electric current is then turned on by a suitable switch, causing the current to flow through the electrodes and intervening tissue; the concentration of current on the needle or active electrode, limits the destruction of tissue to this area and thereby prevents the current from affecting the healthy tissue. Coagulation of tonsillar tissue by this method successfully sears the area at the point where the active electrode is applied, with no effect at any point other than the area between the electrodes. This searing and coagulating effect prevents both superficial and deep bleeding and thereby prevents painful and distressing reactions in healthy tissue.

While I have shown my invention in the particular embodiment above described, it will be understood that I do not limit myself specifically to the steps of treatment described, in carrying out my improved method, and that I do not limit myself specifically to the particular constructions above described, as I may employ equivalents known to the art at the time of the filing of the present application without departing from the scope of the appended claims.

What I claim is:

1. Means for retracting pillars from tonsillar tissue and coagulating the tonsillar tissue, consisting of the combination of an inactive metal electrode having a rigid pillar retracting portion of metal for connection with a first electrical conductor con-

June 17, 1930. H. P. PULLWITT 1,764,347

ELECTROTHERAPEUTIC MACHINE

Filed Oct. 26, 1928 6 Sheets-Sheet 1

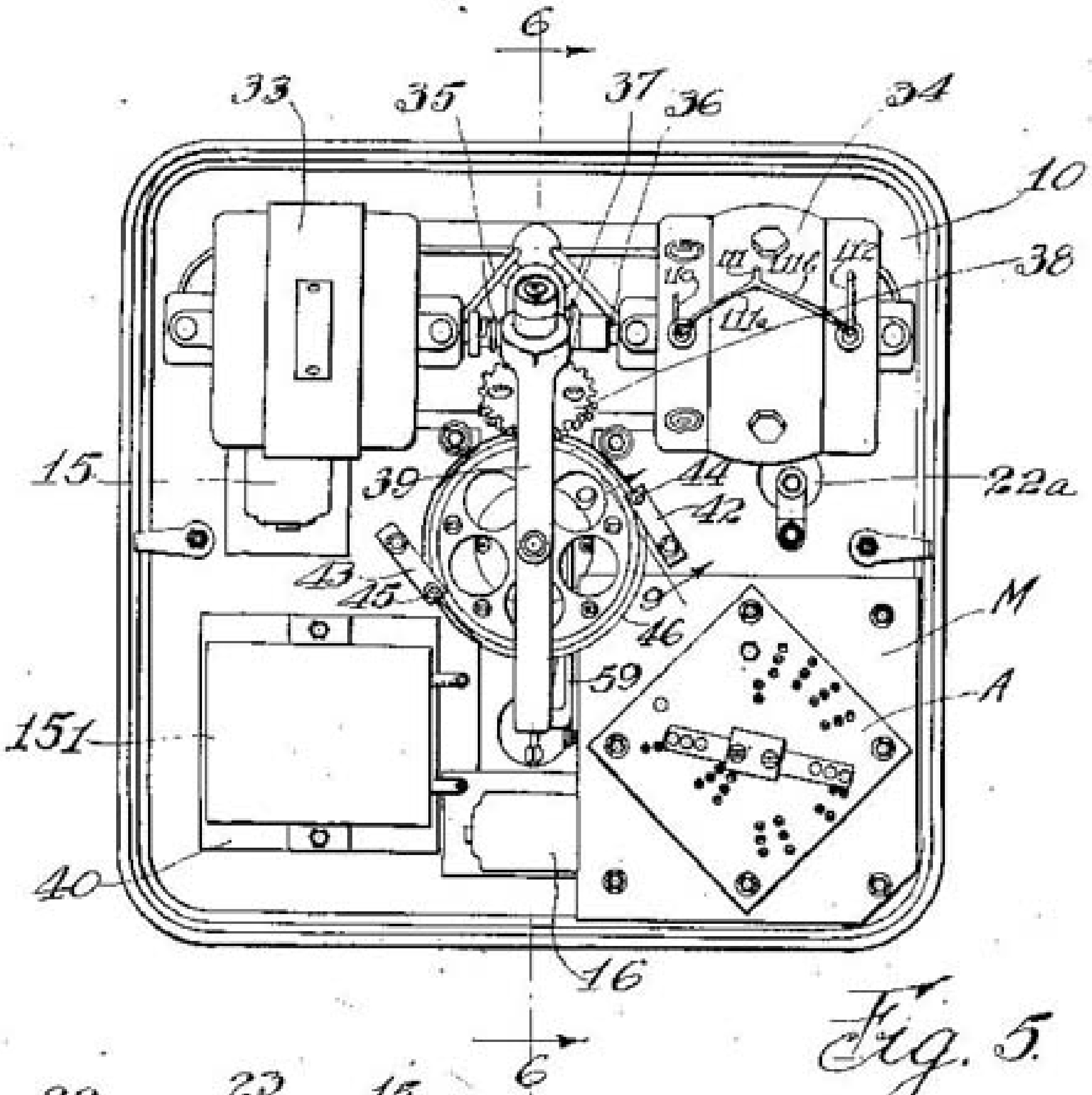


Fig. 5.

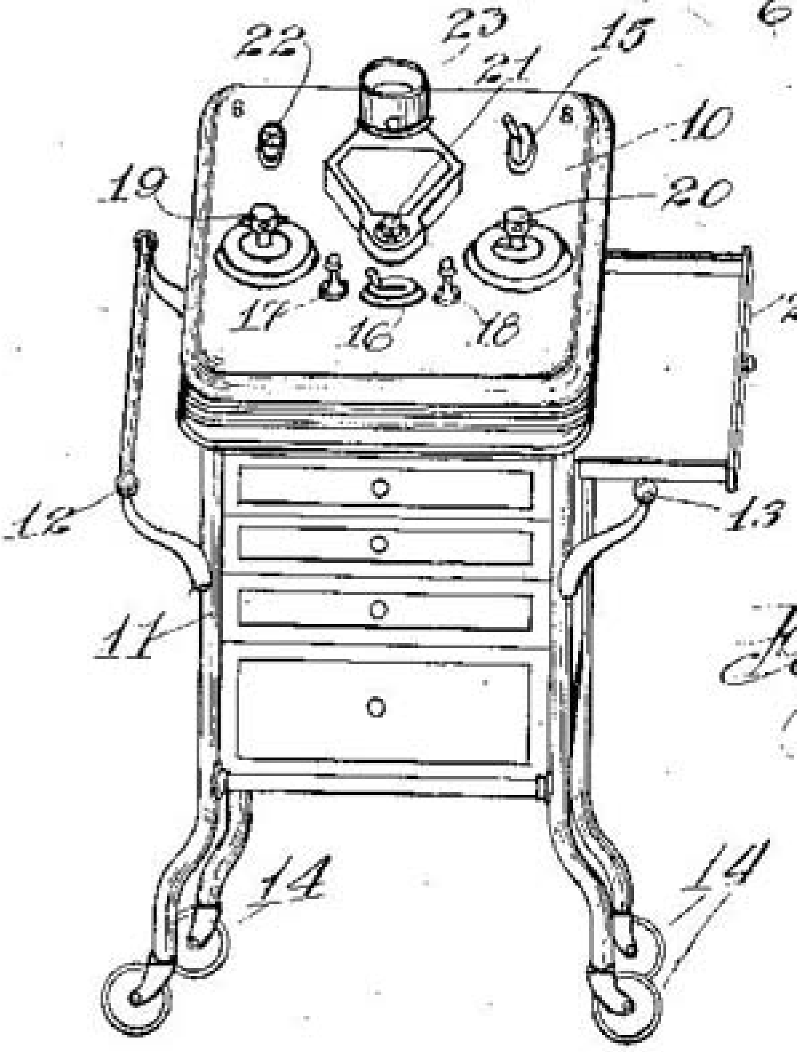


Fig. 1.

INVENTOR
HERMAN P. PULLWITT

BY Albert C. Bell
ATTORNEY.

vibrator active. The rock arm **46** is carried by shaft **47** and this shaft is carried by journals **48** mounted on the tops of posts **49**, the posts being secured to the top of the case **1**. A rock arm **50** is arranged on the end of the shaft and has a screw **51** securing a socket **52** with an insulating pad **53** at the end of the arm. The pad **53** engages a head **54** arranged on the end of a sliding rod **55**. The sliding rod **55** is slidingly mounted in a sleeve **57** and this sleeve is screwed into a supporting sleeve **58** secured on a post **59**. A spring **60** opposes the movement of the rod **55** inwardly and a stop **61** on the rod limits its outward movement. The rod **55** when pulled inwardly makes contact with a head **62** on a rod **63**. The rod **63** is slidingly mounted in a sleeve **63***a* and the sleeve **63***a* is screwed into the sleeve **58**. A contact screw **64** is arranged on the outer end of the rod **63** and secures a contact terminal for the wire **65**. The wire **65** extends to a coupling **66** and a return wire **67** from the coupling leads to a plug **68**, this plug operating in a socket **69** on the plate **1***a*, and the socket **69** being connected with the socket **22**, and therefore with the source of supply. A cord **70** runs from coupling **66** to a motor **71**. The motor is carried by a fan **72** and drives the fan. The fan obtains air through openings **73** and discharges air through a tube connection **74** to the motor **71**, and circulating around the coil and condenser therein and cooling the same. The air may be discharged directly through the atmosphere. The air may be returned by connection **75** to the motor so as to cool the motor. A portion of the air may be returned to a casing **76** of the motor. A portion of the air may be returned to the atmosphere through openings **77** at the rear of the box, these openings being controlled by plate valve or shutter **78**.

A couch or bed **79** on which a patient may recline is provided. The plate **10***b* is secured to a head **80** of the couch by screws **81**, the controlling rod extending through the head and placing the knob in easy reach of the patient **82** reclining on the couch. A cover forming an enclosing means for the patient is provided and the extension is of sufficient length to permit of the applicator being grasped by the operator and used in the treatment of the body and closed by a cover **83**. This treatment produces ozone which is retained by the cover in contact with the body and thus enhances the beneficial effects of the application of the ray to the body. The ray through the applicator may be moved to different parts of the body for treatment. The placing of the control apparatus in easy reach of the patient and so arranged that it may be controlled without substantial opening of the cover makes it possible to vary the intensity and control the ray as desired without substantial loss of the ozone maintained within the cover.

This apparatus by reason of the fan and the cooling effect may be continued over a considerable period whereas the ordinary violet ray apparatus is limited to short periods of use by reason of excessive heat involved, and where the apparatus is used in the manner indicated a longer period is required for the suitable production of ozone and the continued treatment than the ordinary violet ray apparatus will provide.

What I claim as new is:

1. In a current generator designed for use in a violet ray apparatus of the type having a violet ray applicator tube, a resonance coil activating such tube, and a lead from such coil to a current generator, a current supply, a case, the current generator comprising a magnetic coil and condenser enclosed in the case, an electric motor, a fan driven by the motor, connections from the current supply to the motor and to the current generator, a connection leading from the fan to the case providing circulation for the magnetic coil, and a common control means for the apparatus and motor, said control means connecting the supply with the motor in advance of the generation of the ray.

2. In a current generator designed for use in a violet ray apparatus of the type having a violet ray applicator tube, a resonance coil activating such tube and a lead from such coil to a current generator, a current supply, a case, the current generator comprising a magnetic coil and condenser enclosed in the case, an electric motor, a fan driven by the motor, connections from the current supply to the motor and to the current generator, a connection leading from the fan to the case providing circulation for the magnetic coil, and a connection returning air from the case into cooling relation with the motor.

3. In a current generator designed for use in a violet ray apparatus of the type having a violet ray applicator tube, a resonance coil activating such tube, and a lead from such coil to a current generator, a case, the current generator comprising a magnetic coil and condenser enclosed in the case, an electric motor, a fan driven by the motor, a connection from the fan directing air on the magnetic coil, a current supply for the magnetic coil and motor, a switch controlling the said supply, and a control for the vibrator, said control actuating the switch.

4. In a current generator designed for use in a violet ray apparatus of the type having a violet ray applicator tube, a resonance coil activating such tube and a lead from such coil to a current generator, the current generator comprising a magnetic coil and condenser, an electric motor, a fan driven by the motor, a connection from the fan directing air on the magnetic coil, a current supply for the magnetic coil and motor, a switch controlling the said supply, and a control for the vibrator, said control actuating the switch in advance of putting the vibrator in action.

5. In a current generator designed for use in a violet ray apparatus of the type having a violet ray applicator tube, a resonance coil activating such tube and a lead from such coil to a current generator, the current generator comprising a magnetic coil, a vibrator acting with the magnetic coil, an operating rod for the vibrator, said rod putting the vibrator into action initially and controlling the vibrator in action to control the ray, an electric motor, a fan driven by the motor, a connection from the fan directing air on the magnetic coil, a current supply for the magnetic coil and motor, a switch controlling the supply, said switch comprising a rock arm in the path of the operating rod, a shaft actuated by the rock arm, a switch arm on the shaft, a switch rod moved by the switch arm, means for adjusting the relation of the switch rod and the arm, a switch closed by the switch rod, yielding means for the switch rod permitting a continued movement thereof after contact to permit of a control movement of the operating rod.

CHRISTIAN G. FILZER.

UNITED STATES PATENT OFFICE.

WENDELL L. CARLSON AND EARL C. HANSON, OF WASHINGTON, DISTRICT OF COLUMBIA.

ELECTROTHERAPEUTIC APPARATUS.

1,338,812. Specification of Letters Patent. Patented May 4, 1920.

Application filed July 12, 1919. Serial No. 310,352.

To all whom it may concern:

Be it known that we, Wendell L. Carlson and Earl C. Hanson, citizens of the United States, residing at Washington, District of Columbia, have invented certain new and useful Improvements in Electrotherapeutic Apparatus, of which the following is a specification.

Our invention relates to the art of electrotherapeutics and has for its object means for producing and utilizing steady sustained high frequency currents for imparting beneficial effects to the body.

Heretofore difficulty has been experienced in obtaining steady sustained currents of a frequency that would not affect the nervous system of the patient under treatment. Present high frequency apparatus is not satisfactory for the reason that the patient is subject to severe shocks from currents of a varying frequency.

Our invention will be more fully understood by referring to the accompanying drawings in which the three figures are diagrammatical illustrations of different forms of applicant's invention. In Figure 1 numeral 1 represents an oscillating vacuum tube having a filament 2 heated by a battery 3, a grid 4 connected through the inductance 6 to the filament 2. The plate 5 is connected through the inductance 7 and through a direct current high voltage generator 8 to the filament 2. The generator 8 is shunted by a high capacity fixed condenser 9. Inductively coupled to the inductances 6 and 7 is an inductance 10 which is connected in a series circuit consisting of the variable capacity 11, electrodes 12 and 14 and thermo-ammeter 13. In Fig. 2 inductance 10 has one terminal grounded at 15 through thermo-ammeter 13, the other terminal of which is connected to a vacuum electrode 16. Fig. 3 shows diagrammatically the inductance 10 connected through the variable capacity 11 to the inductance coil 17 and a thermo-ammeter 13. In Fig. 1 the electrodes 12 and 14 are suitably constructed so as to be applied directly to the body of the patient. The oscillating currents set up in the circuit above described passing through the body between the electrodes 12 and 14 produce a highly beneficial effect. All of the inductances employed are variable as indicated by the arrows.

The operation of the system is as follows: The oscillating vacuum tube circuit shown in Fig. 1 is adjusted so as to generate sustained high frequency oscillations. The inductance 10 is inductively coupled to the inductances 6 and 7, the result of which is the transfer of high frequency energy to the circuit comprising the inductance 10, variable condenser 11, electrodes 12 and 14 and thermo-ammeter 13. In electrotherapeutics this current is known as the D'Arsonval current.

In Fig. 2 the inductance 10 is shown connected in circuit with a vacuum electrode 16, thermo-ammeter 13 and ground 15. The vacuum electrode 16 is applied to the surface of the body and produces the well-known Tesla current effect.

In Fig. 3 the inductance coil 17 is substituted for the electrodes 12 and 14 shown in Fig. 1 and brought near the patient's body. High frequency current is induced in the patient's body due to the eddy current effect produced by the magnetic field created around the inductance 17 by the sustained high frequency currents surging therein. The circuits are adjusted to resonance at a frequency substantially above that frequency which would be detected by the nervous system of the body.

In the practical operation of this system the advantages over the methods used in the prior art lie in the fact that steady sustained high frequency oscillations are produced by the oscillating vacuum tube circuit in lieu of the unsteady currents produced by the apparatus as now employed in electrotherapeutics.

We claim:

1. In electrotherapeutics, the combination of an oscillating vacuum tube circuit for the generation of sustained high frequency currents substantially above that frequency which effects the nervous system of the body, with means for tuning the oscillating circuit, and means for applying said sustained high frequency currents to the body of a patient to produce beneficial effects therein, substantially as and for the purpose described.

2. In electrotherapeutics, the combination with a plurality of hand electrodes connected in circuit with a variable capacity and inductance, and an indicating meter, of a vacuum tube oscillating circuit associated with said inductance and adapted to pro-

duce steady sustained high frequency oscillations, substantially as and for the purpose described.

3. In electrotherapeutics, a vacuum tube oscillator adapted to produce sustained oscillations, and means for tuning said oscillations, said vacuum tube oscillator including a circuit containing inductances, in combination with a circuit containing means for applying said current to the body, substantially as and for the purpose described

WENDELL L. CARLSON.
EARL C. HANSON.

Oct. 2, 1923. 1,469,471

E. ABA

ELECTROTHERAPEUTIC APPARATUS

Filed Nov. 12, 1921

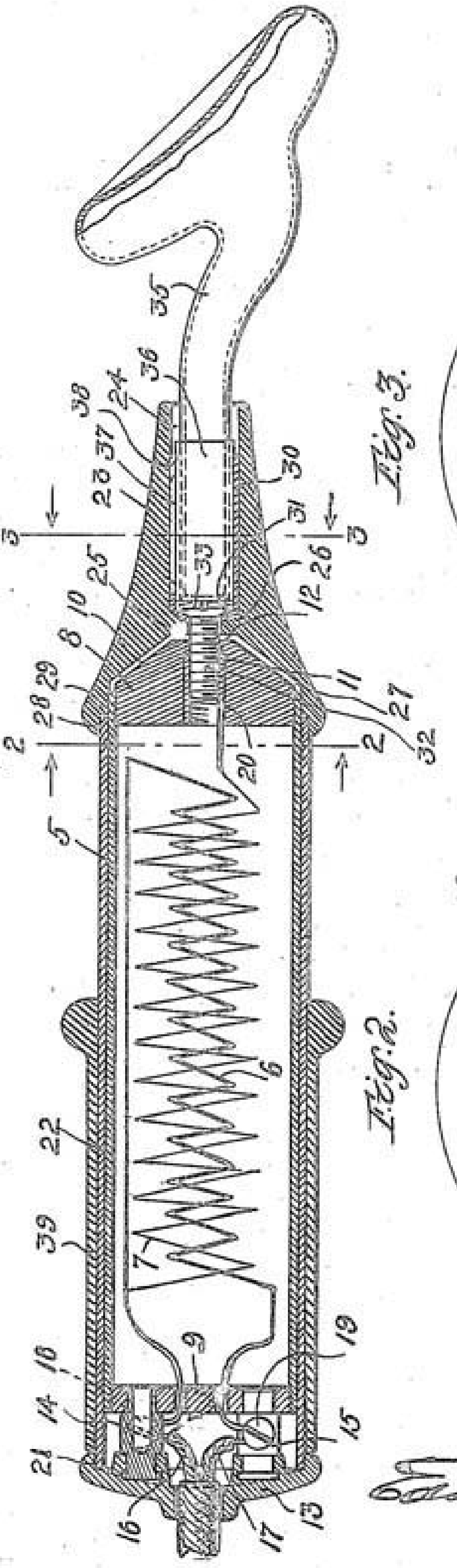


Fig. 1.

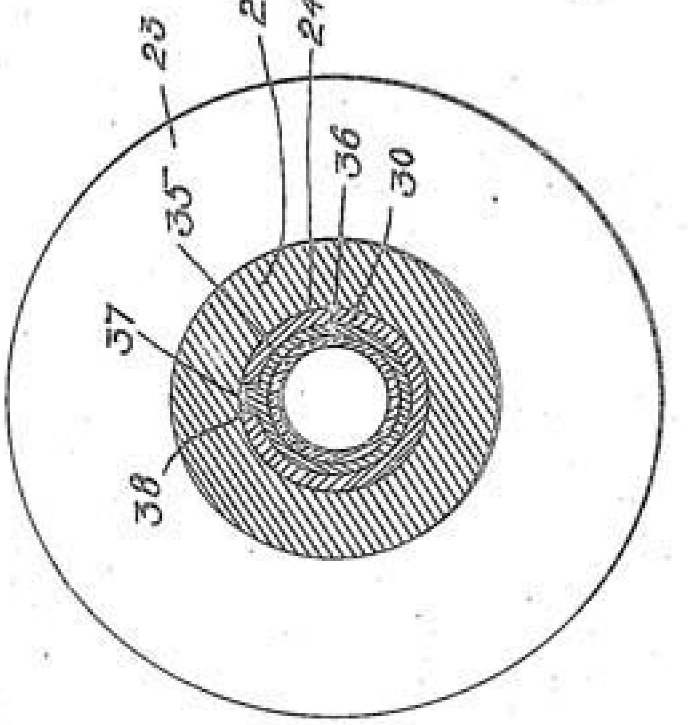


Fig. 3.

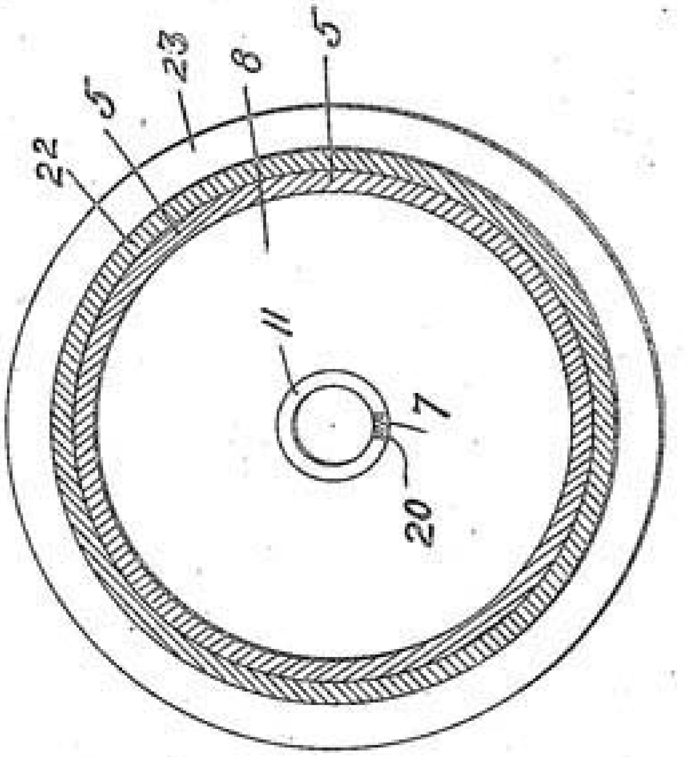


Fig. 2.

Inventor
Eugene Aba.

By

atty.

Patented Oct. 2, 1923. **1,469,471**

UNITED STATES PATENT OFFICE.

EUGENE ABA, OF LOS ANGELES, CALIFORNIA.

ELECTROTHERAPEUTIC APPARATUS.

Application filed November 12, 1921. Serial No. 514,570.

To all whom it may concern:

Be it known that I, Eugene Aba, a citizen of the United States, residing at Los Angeles, in the county of Los Angeles and State of California, have invented new and useful Improvements in Electrotherapeutic Apparatus, of which the following is a specification.

My invention relates more particularly to electrode holders or handles to which the electrode or vacuum glass of electrotherapeutic apparatus may be conveniently attached and which forms a casing for the high frequency induction coil or resonator of such apparatus.

The object of my invention is to provide a holder for the purpose above mentioned which may be quickly, conveniently and rigidly assembled and readily taken apart, which will provide a thorough insulation of the electrical units contained therein, to eliminate all danger of the user sustaining a shock, and whereby all electrical connections may be quickly and thoroughly made.

Another object of my invention is to provide a construction whereby the necessity of threading the outer covering shell of insulating material to the end pieces will be dispensed with, thereby eliminating the expense of threading these parts.

Still another object of my invention is to provide a convenient socket connection between the holder and electrode which will insure a perfect electrical connection as well as prevent the twisting or turning of the electrode in said connection.

The above and other objects of my invention will be more specifically pointed out in the following description, and illustrated in the accompanying drawings, in which:

Fig. 1 is a longitudinal section through a holder showing the detail construction of my invention.

Fig. 2 is an enlarged transverse section through the holder taken on the line 2—2 of Fig. 1.

Fig. 3 is an enlarged transverse section through the holder taken on the line 3—3 of Fig. 1.

In carrying out my invention 5 represents a stay or binding member which for convenience of construction comprises a tube formed of insulating material adapted to receive the primary and secondary windings 6 and 7 of the induction coil. The tubular stay bolt 5 is interiorly threaded at its opposite ends to receive the threaded plug members 8 and 9, the plug 8 being located adjacent the electrode end of the holder and the plug member 9 being located adjacent the electrical energy supply end of the holder.

The end 10 of plug projects out from the stay member 5 and is frusto-conical in shape, and said plug 8 is provided with a centrally disposed bore into which is pressed an interiorly threaded sleeve 11 of brass or other electrical conductive material, said sleeve abutting against a shoulder 12 formed in said bore adjacent its outer end.

An end cap 13 is spaced apart from the plug 9 and held secured thereto by means of a pair of binding posts 14 and 15, said end cap being provided with a centrally disposed aperture for the admission of the lead wires 16 and 17 which are secured to said binding posts by means of the binding screws 18 and 19, the leads from the primary winding 6 passing through apertures in block 9 and also being secured to said binding posts by means of the screws 18 and 19.

The sleeve 11 is provided with a longitudinal saw cut 20 into which the lead from the secondary winding 7 is disposed and soldered therein, thus forming an efficient electrical connection to said sleeve.

The cap 13 is provided with a socket 21 adapted to receive one end of the outer tubular casing 22 which is formed of insulating material and adapted to surround the tubular stay member 5, said end abutting adjacent said end cap.

An end or nose piece 23 formed of insulating material is provided with a bore 24 extending inwardly from its outer end, for a suitable distance, and a bore 25 of smaller diameter connecting with said bore to form a shoulder 26. The bore 25 communicates with an enlarged bore 27 adapted to receive the end of the tubular stay member 5 and the end 10 of plug 8. The bore 27 is enlarged at 28 to receive the forward end of the tubular casing 22 and to form a shoulder 29 against which said end is adapted to abut.

A metallic conductor sleeve or socket 30 preferably formed of brass, is secured in the bore 24, and is provided at its inner end with an inturned flange 31 adapted to rest against the shoulder 26 of end or nose piece 23. A screw 32, preferably formed of brass, passes through the bore 25 and is threaded into the sleeve 11, the head 33 of said screw shouldering against the inturned flange 31 of conductor sleeve 30.

The conductor sleeve 30 is adapted to receive the stems of vacuum glass electrodes of various shapes, one of which is shown at 35, and each electrode has secured on its stem a brass sleeve 36, having formed on its outer surface a fin 37, adapted to engage in a slot 38 formed in conductor sleeve 30, in order that the electrode will be prevented from turning when socketed in said conductor sleeve.

In order that the hand of the operator may be additionally protected a sleeve 39 of soft rubber may be slipped over the casing sleeve 22.

By the foregoing recited construction it will be obvious that all of the parts are held firmly bound together by the screw 32, and perfect electrical connections are made, and by removing the electrode 35 and engaging the screw head 33 with a screw driver, the screw 32 may be removed, thus permitting the ready removal of the end or nose piece 23 and the casing 22. The end cap 13 and the plug 8 may then be readily removed, and access to the coils and all electrical connections and units may be had.

What I claim is:

1. An electrode holder, comprising a pair of end pieces, a casing interposed between said end pieces, a stay member mounted in said casing, and means for removably securing said end pieces to said stay member, whereby said casing may be firmly bound between said end pieces.

2. An electrode holder, comprising a casing, a stay member mounted in said casing and adapted to engage with one of its ends, a nose piece adapted to engage with the opposite end of said casing, and means for detachably securing said nose piece to said stay member.

3. An electrode holder, comprising a casing, a stay member mounted in said casing and adapted to engage with one of its ends, a nose piece adapted to engage with the opposite end of said casing, said stay member being provided with a centrally disposed threaded aperture and said nose piece being provided with a centrally disposed aperture adapted to register with said first mentioned aperture and provided with a shoulder, and a threaded member adapted to engage with said threaded aperture and said shoulder.

4. An electrode holder, comprising a casing, a stay member mounted in said casing, one end of said stay member being adapted to engage with one end of said casing, said stay member having formed in its opposite end a threaded aperture, and a nose piece provided with an inwardly projecting centrally disposed threaded member adapted to engage with said threaded aperture in said stay member.

5. An electrode holder, comprising a casing, a stay member mounted in said casing, one end of said stay member being adapted to engage with one end of said casing, said stay member being provided at its opposite end with a centrally disposed threaded sleeve, a nose piece adapted to engage with the opposite end of said casing and provided with an electrode receiving socket, a sleeve provided with a slot secured in said socket and having a shoulder formed at its inner end, and a screw adapted to engage with said shoulder and threaded sleeve.

6. In a high frequency apparatus, a tubular handle formed of an insulating material, a transformer mounted therein, a nose piece formed of an insulating material having a centrally disposed electrode receiving socket formed therein, a metal contact sleeve mounted in said socket, and an electrical conductor for detachably securing the nose piece to said casing and for forming an electrical connection between the contact sleeve and said transformer.

In witness that I claim the foregoing I have hereunto subscribed my name this 20th day of October, 1921.

EUGENE ABA.

May 5, 1925. **1,537,012**

B. F. JANCKE

COIL SUPPORT FOR HIGH TENSION DEVICES

Filed Feb. 13, 1922

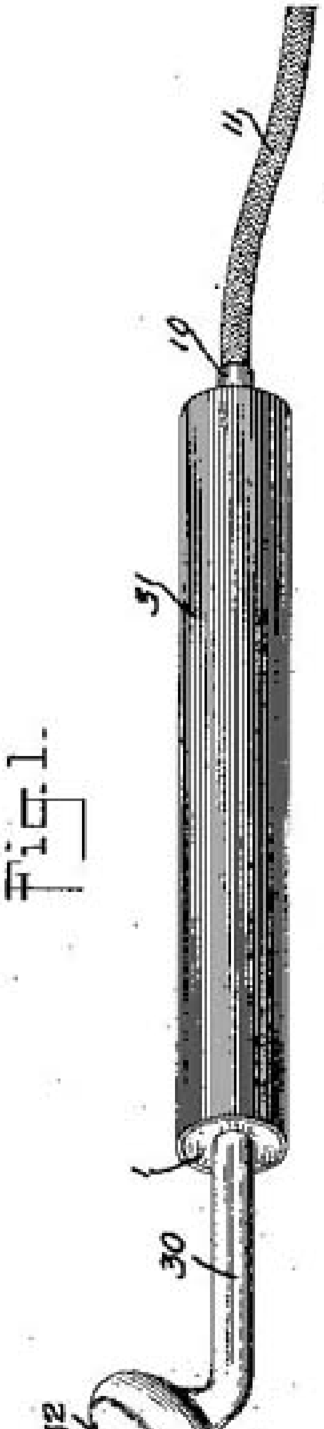


Fig. 1.

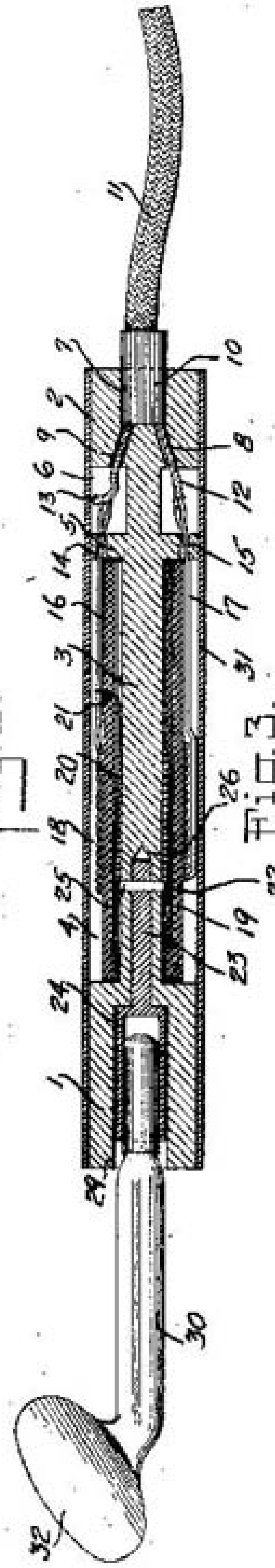


Fig. 2.

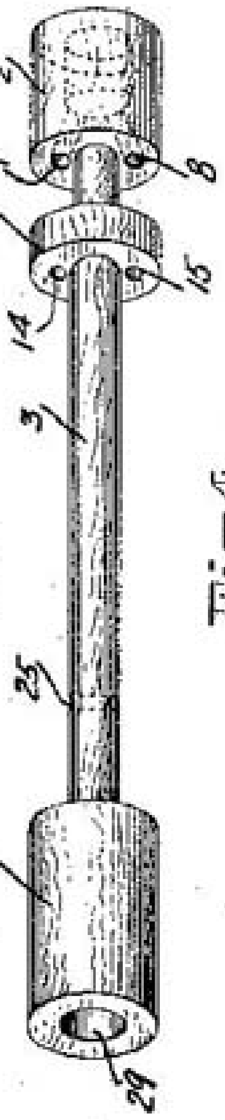


Fig. 3.

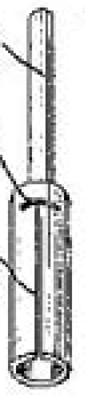


Fig. 4.

WITNESSES

William P. Goebel.

Robert. I. Hulsizer.

INVENTOR

Benno F. Jancke

BY Munn & Co

ATTORNEYS

Patented May 5, 1925. **1,537,012**

UNITED STATES PATENT OFFICE.

BENNO FREDERIC JANCKE, OF BROOKLYN, NEW YORK.

COIL SUPPORT FOR HIGH-TENSION DEVICES.

Application filed February 13, 1922. Serial No. 536,235.

To all whom it may concern:

Be it known that I, BENNO F. JANCKE, a citizen of Germany, and a resident of the city of New York, borough of Brooklyn, in the county of Kings and State of New York, have invented a new and Improved Coil Support for High-Tension Devices, of which the following is a full, clear, and exact description.

This invention relates to coil supports for high tension devices, and has particular reference to such devices as are used for the application of electrical rays to body surfaces in the treatment of diseases or affections of the skin.

An object of the invention resides in the construction of a coil support in such manner that it can be used as a handle for the device and in which the cost of manufacture is reduced to a minimum by the simplicity of construction.

Another object resides in the provision of means whereby the handle and coil support can be very readily assembled and disassembled for adjustment and repair.

A further object resides in the particular construction and arrangement of parts which are hereinafter described and claimed and shown in the accompanying drawings.

The invention is illustrated in the drawings, of which—

Figure 1 is a perspective view of the device;

Figure 2 is a longitudinal section therethrough;

Figure 3 is a perspective view of the coil support or spindle before the coil is wound thereon; and

Figure 4 is a perspective view of the electrode socket.

The invention as shown in the drawings is a preferred form of my invention, although it is to be understood that variations in the arrangement and construction of the parts and in the kind of materials used may be made in this device without departing from the operative spirit of the invention as set forth.

The device comprises essentially a body spindle having head portions 1 and 2 and an intermediate portion 3 of considerably reduced diameter forming a hollow annular chamber 4 in which the coil is mounted. A collar 5, preferably integral with the body portion, is provided and spaced from the head portion 2 to form a hollow chamber 6 in which suitable connections to the coil are very readily disposed and made. An aperture 7 and passageways 8 and 9 are provided in the head portion 2, the first for the terminal plug 10 of a suitable cable 11 containing the wires, and the latter disposed to receive the individual wires 12 and 13 which extend into the chamber 6. The collar 5 is provided with apertures 14 and 15 through which extend conductors 16 and 17 forming the ends of a primary coil 18. This primary coil is wound over a plurality of layers of insulating material 19, such as suitably prepared paper, beneath and between which are wound any suitable number of layers of a secondary coil 20. This secondary coil is disposed, therefore, between the reduced portion 3 of the spindle and the primary coil 18. One end of the secondary coil is connected by a conductor 21 to a primary wire such as 16. The other end of the secondary coil is connected by a pin 22 to the end 23 of a socket portion 24. The pin 22 is disposed to fit snugly in an aperture 25 in the reduced portion of the spindle 3 leading to a narrow bore 26 adapted to receive the extension 23 of the socket portion 24. The socket 24 is made of any suitable conducting material, the main body portion of which is in the form of a hollow cylinder split as at 27 and 28 to provide the desired amount of flexibility. This body portion of the socket 24 is disposed within a larger bore 29 extending in from the end of the head 1. Any suitable electrode or connection, such as 30, may be inserted in the socket 24 to make proper connections to the coil. A suitable cylindrical sleeve 31 is slipped over the head portions 1 and 2 and the collar 5 to provide a cover for the device as well as to act as a handle portion. This cover may be of any suitable material, such as a heavy grade of paper.

This device acting as a coil support and a handle portion for the electrode 30 is especially applicable for use in connection with the application of high frequency electricity in the treatment of various diseases. The electrode 30 is shown in the form of a glass tube having an enlarged head portion 32 which, as is customary, is passed over the surface to be treated.

It will, therefore, be apparent from a consideration of the description of the construction above set forth that the body portion of the coil support can be made, preferably of wood, out of one piece of material which can be very readily turned down to the proper form on a wood turning lathe. The application of the coil to the intermediate portion of reduced diameter in the manner well known is a comparatively simple proceeding, and the coil fits snugly in this space without enlarging the size of the body portion beyond its original dimensions. The provision of the hollow chamber 6 gives ample space for making the necessary electrical connections. The provision of a simple sleeve of any suitable material to slip over the spindle not only forms a cover but a neat appearing and efficient handle portion whereby the device may be readily manipulated. The entire construction is reduced to the simplest elements possible and, consequently, the assembly and repair are made very easy and the cost of manufacture is reduced to a minimum.

What I claim is:

1. A handle portion for therapeutic devices, which comprises a spindle having a plurality of portions of reduced diameter to form chambers, a transformer coil mounted on one portion of reduced diameter, another portion of reduced diameter forming a chamber in which cylindrical connections to said coil can be made, said spindle at one end having a bore, a socket disposed in said bore, and a connection between the end of said socket and said transformer.

2. A handle portion for therapeutic devices, which comprises an integral spindle of wood having enlarged head portions at each end and a collar portion of enlarged diameter spaced from one of said head portions, a transformer coil mounted on the spindle between the head portion and said collar, one of said head portions having a bore and apertures leading therefrom, a cable disposed in said bore the wires of which project through said apertures, said collar having apertures through which the leads from the transformer coil extend and connect with the wires from the cable in the space between the collar and the head, and a sleeve disposed over the spindle to form a handle portion and a cover therefor.

3. A handle portion for therapeutic devices, which comprises a wooden spindle having a portion intermediate its ends of reduced diameter, a transformer coil mounted on said portion of reduced diameter, the end of said spindle provided with a bore extending inwardly therefrom, a hollow cylindrical socket portion disposed in said bore having an integral portion extending inwardly therefrom, and a connection between said extension and one of the transformer coils.

4. A handle portion for therapeutic devices, which comprises a wooden spindle having enlarged head portions at each end thereof and an enlarged collar portion spaced from one of said head portions, one of said head portions provided with a bore to receive a socket and with an aperture extending from the bottom of said bore inwardly along the spindle, the spindle provided with a transverse passageway leading to the end of said aperture, the other of said head portions provided with a bore to receive a cable and with passageways leading from the bottom of the bore to the inner face of the head adjacent the collar, said collar portion provided with apertures to permit the passage of electrical wires extending from a coil mounted on the main portion of the spindle into the space between the wire and the head portion.

5. A handle portion for therapeutic devices, which comprises an integral spindle having an enlarged head portion with a bore therein and a passageway leading from the bottom of said bore inwardly along the spindle, a hollow cylindrical socket disposed in said bore having an extended portion leading therefrom along said passageway, said socket being split, said spindle having a transverse aperture across said passageway, and a pin disposed in said transverse aperture and passing through the extension of the socket to make electrical connections therewith and also to lock the socket in the bore.

BENNO FREDERIC JANCKE.

Feb. 2, 1926. **1,571,508**

W. L. CARLSON ET AL

ELECTROTHERAPEUTIC APPARATUS

Filed March 24, 1921 2 Sheets-Sheet 1

Fig. 1.

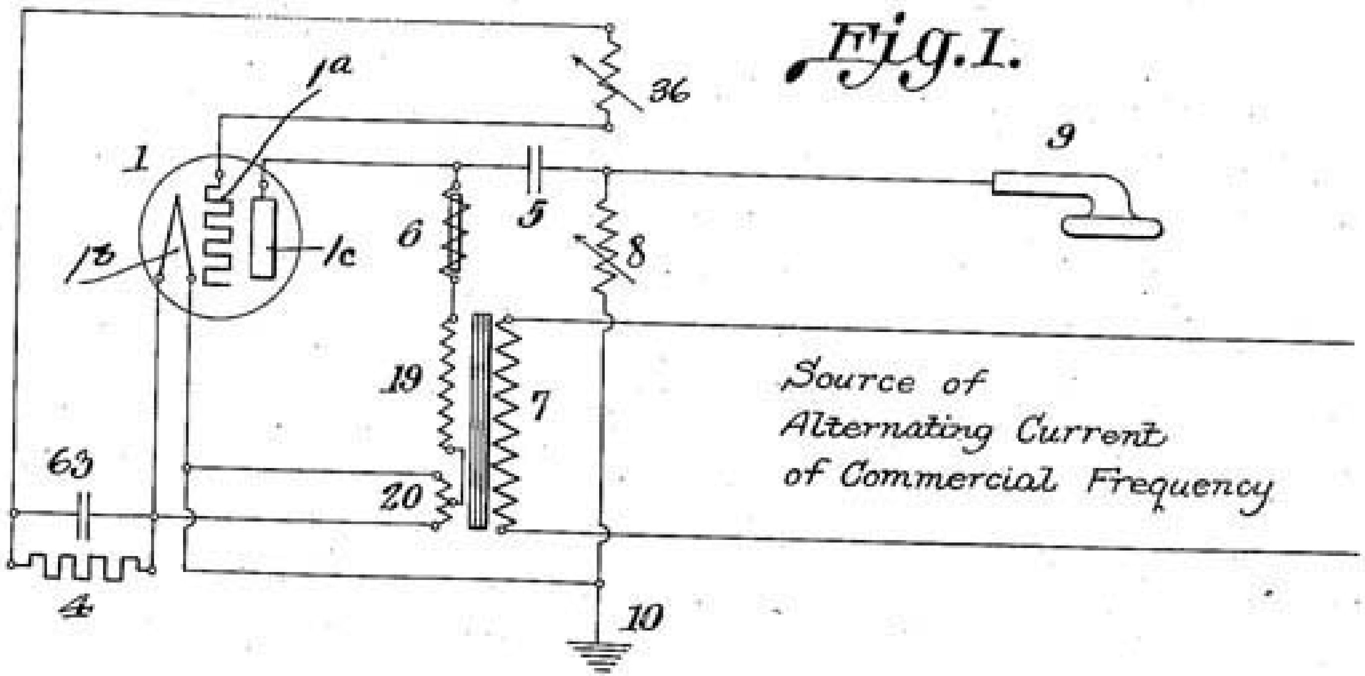


Fig. 2.

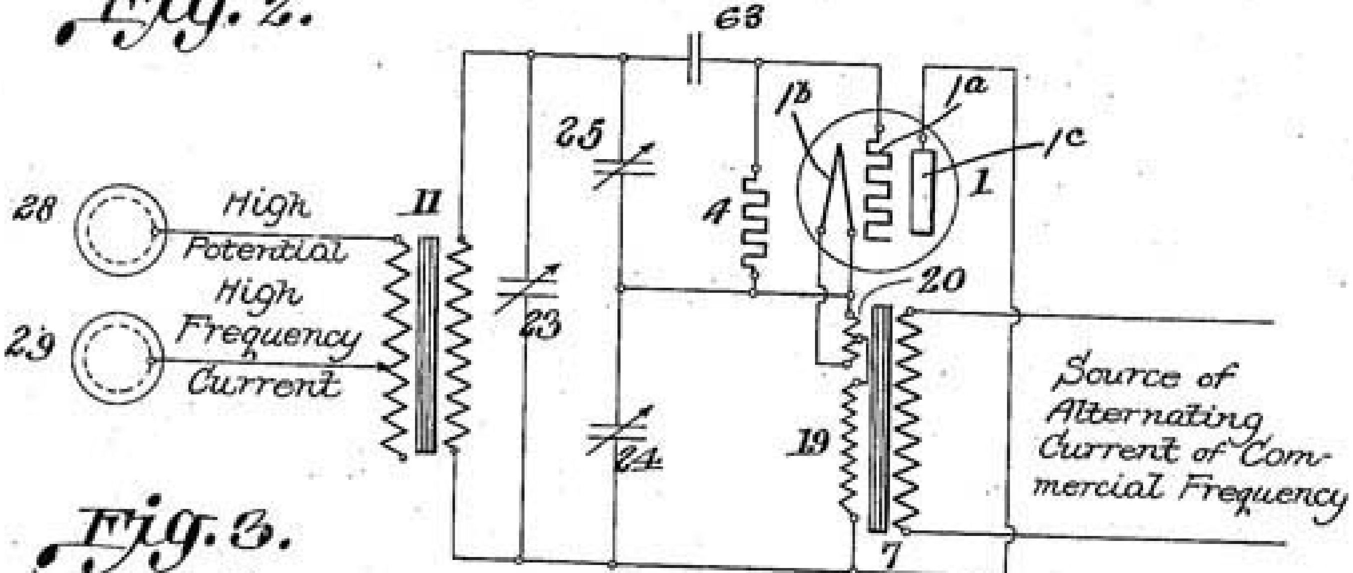
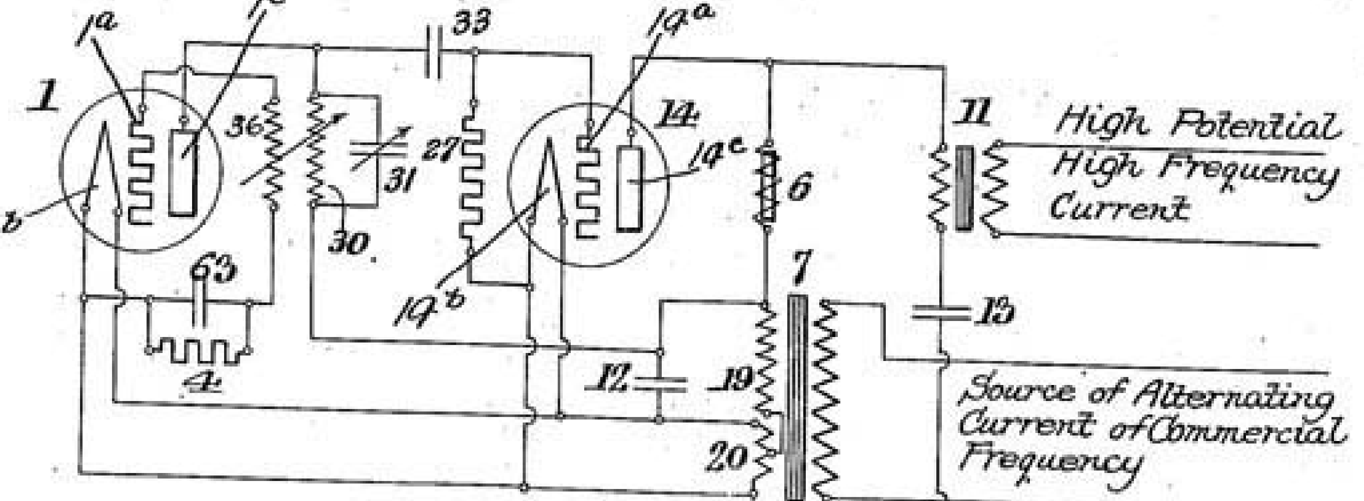

63
1b
1a
1c
25
4
1
28
High Potential High Frequency Current
11
20
29
23
Source of Alternating Current of Commercial Frequency
19
24
7

Fig. 3.


1a
1c
33
14a
1
36
27
14
14c
11
High Potential High Frequency Current
31
6
1b
30
14b
63
7
13
4
12
19
Source of Alternating Current of Commercial Frequency
20

Inventors

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Wendell L. Carlson.

by John B Brady

Attorney

Feb. 2, 1926. **1,571,508**

W. L. CARLSON ET AL

ELECTROTHERAPEUTIC APPARATUS

Filed March 24, 1921 2 Sheets-Sheet 2

Fig. 4.

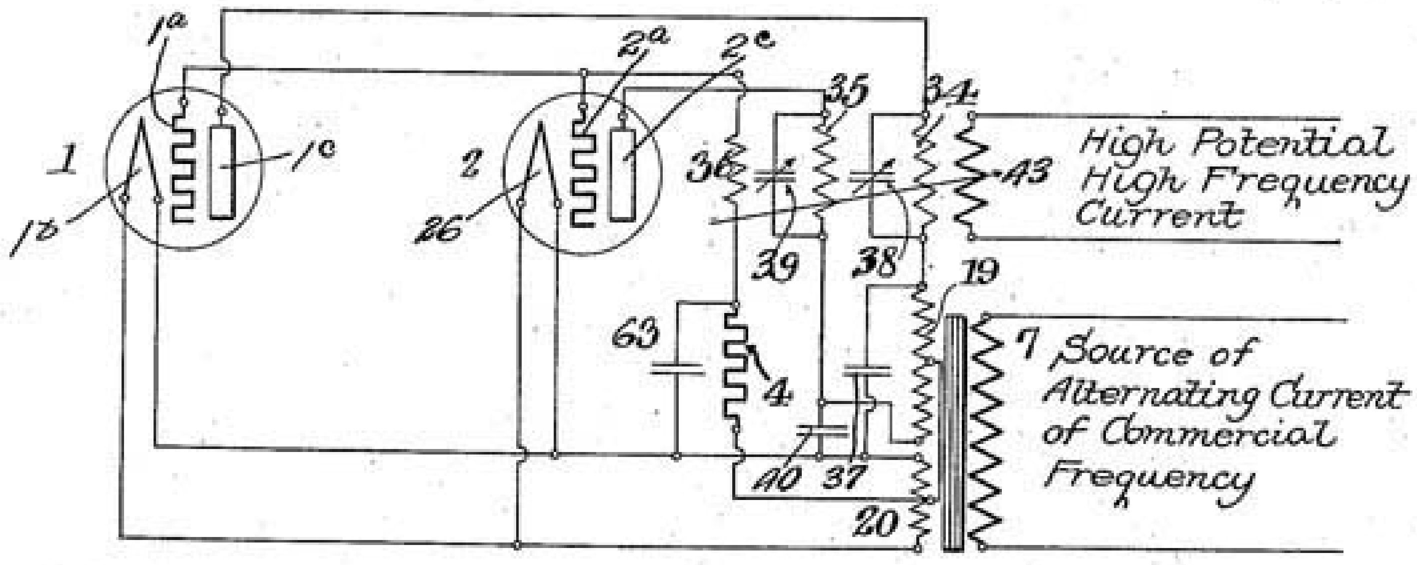
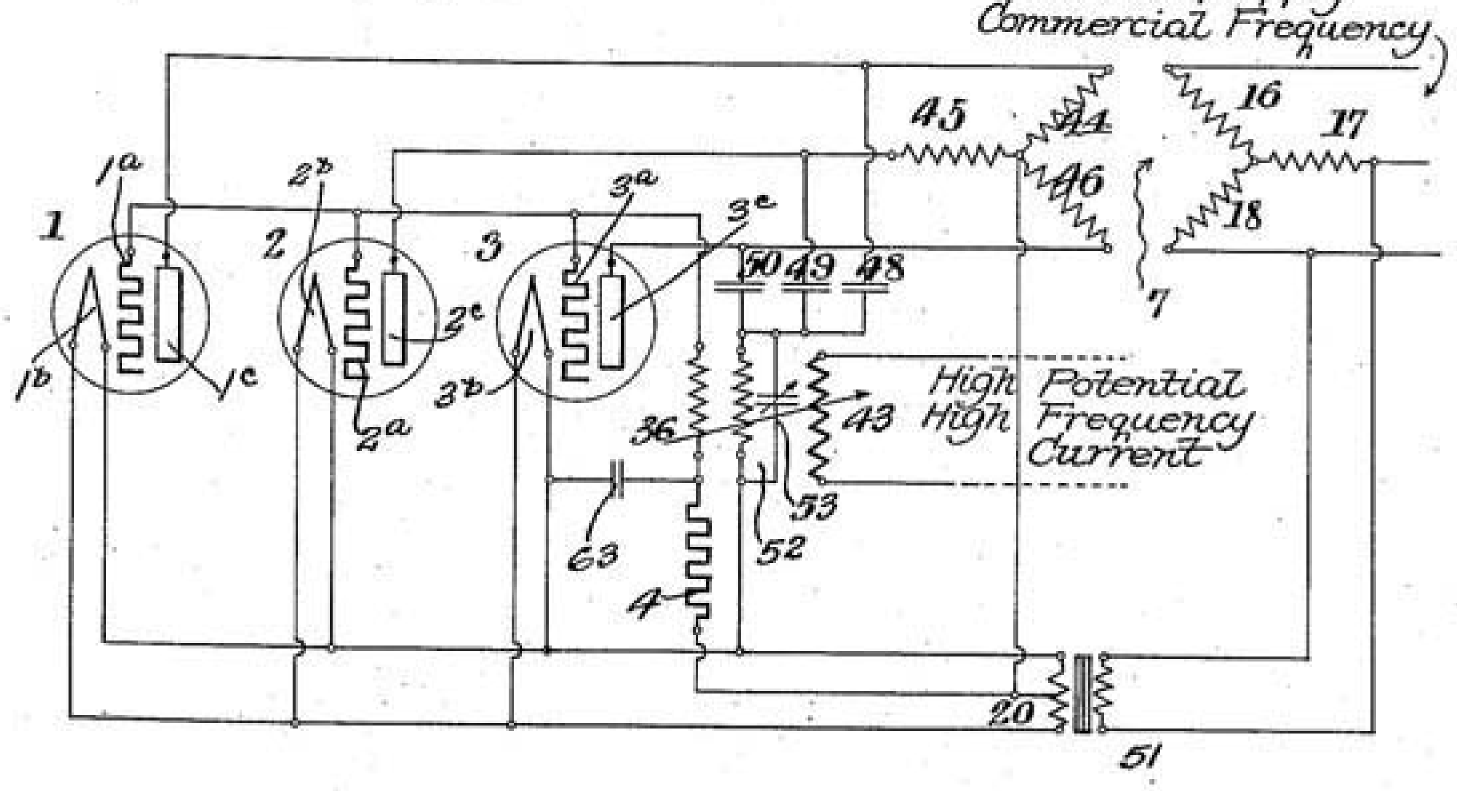


Fig. 5.



Inventors
Glenn W. Carpenter
Wendell L. Carlson.
by John B. Brody,
Attorney

Patented Feb. 2, 1926. **1,571,508**

UNITED STATES PATENT OFFICE.

WENDELL L. CARLSON AND GLENN W. CARPENTER, OF WASHINGTON, DISTRICT OF COLUMBIA.

ELECTROTHERAPEUTIC APPARATUS.

Application filed March 24, 1921. Serial No. 455,106.

To all whom it may concern:

Be it known that we, Wendell L. Carlson and Glenn W. Carpenter, citizens of the United States, residing at Washington, District of Columbia, have invented certain new and useful Improvements in Electrotherapeutic Apparatus, of which the following is a specification.

Our invention relates broadly to an apparatus for electrically producing beneficial effects in the body and more particularly to electrotherapeutic apparatus in which thermionic vacuum tubes are employed in the production of high frequency oscillations at a frequency above that which effects the nervous system of the body.

The object of the invention is to provide an electrotherapeutic equipment including vacuum tube oscillators which may be operated from sources of alternating current of commercial frequency and which requires no special generators heretofore necessary in this form of equipment.

Another object of our invention is to provide means for increasing the amplitude of oscillations developed by vacuum tube electrotherapeutic apparatus and applying this high frequency current to the body of a patient.

A further object of the invention is to provide means for operation of electrotherapeutic apparatus on polyphase supply circuits for the development of high frequency oscillations.

Other and further objects of the invention will be clear from the specification following and by reference to the accompanying drawings in which;

Figure 1 shows a vacuum tube oscillator having the high frequency anode circuit connected directly to the operating electrode and supplied with an alternating current source of commercial frequency.

Figure 2 shows a vacuum tube oscillator having a capacity back coupled circuit and an iron core high frequency output transformer.

Figure 3 shows an equipment in which one tube operates as an oscillator and the other tube as an amplifier.

Figure 4 shows two tubes operating in parallel, and

Figure 5 is a circuit arrangement for three tubes operated from a three phase source of current.

Referring particularly to the drawings the circuit in Figure 1 includes power tube 1 having its grid element 1^a connected through inductance 36 and capacity 63 to the cathode or filament 1^b. The high resistance shunt 4 gives the proper bias voltage to the grid 1^a. The transformer 7 has two secondary windings, 19 and 20, winding 19 to step-up the voltage for the anode 1^c or plate circuit potential and the winding 20 to step-down the voltage to supply the filament current. The primary winding of transformer 7 is energized from a source of alternating current of commercial frequency. Choke coil 6 prevents the secondary 19 and 20 from shorting the high frequency plate circuit consisting of capacity 5 and inductance 8. Windings 36 and 8 in the grid and plate circuits respectively are inductively coupled providing the high frequency feed back path between the circuits. The high frequency currents developed by these circuits are applied to the patient's body by electrode 9. The electrode 9 is connected to one end of coil 8 and forms one element of a condenser acting through the medium of the patient's body in conjunction with the grounded opposite terminal 10 to give the required capacity shunting coil 8 to provide a resonance circuit.

In Figure 2, reference character 1 indicates a high power vacuum tube connected to an associated oscillating circuit consisting of output high frequency transformer 11 shunted by variable capacities 23, 24 and 25. The common terminal of capacities 24 and 25 is connected to the lead from filament 1^b of tube 1. Capacity 63 joins one end of the oscillating circuit to the grid element 1^a of tube 1. The high voltage secondary winding 19 of the transformer 7 is connected in the plate circuit between the plate element 1^c of tube 1 and the filament 1^b. The other end of the oscillating circuit connects to the lower terminal of winding 19. Filament current is supplied through stepdown transformer winding 20 on transformer 7. Resistance 4 gives bias grid potential. Pad electrodes 28 and 29 supply the high frequency current to the patient's body thru the adjustable transformer 11 having an iron core.

In Figure 3 the tube 1 is associated with inductance 36, capacity 63 and resistance 4 in its grid circuit. Inductance 30 in plate circuit is coupled to inductance 36 and shunted with tuning capacity 31. Plate voltage is supplied through transformer 7. A high frequency path is provided through condenser 12 shunting high voltage winding 19 of transformer 7. The plate element 1^c of tube 1 is connected through capacity 33 to grid element 14^a of tube 14. Grid bias potential on tube 14 is obtained through resistance 27. Plate voltage to tube 14 is obtained from transformer 7 through choke coil 6. An iron core high frequency output transformer in series with condenser 13 is connected across the plate 14^c and filament 14^b of tube 14. The output terminals may be applied for electrical treatment of a patient's body in any of the the well-known methods.

Figure 4 illustrates a method of utilizing both halves of the cycles of the low frequency plate current supply. The plates 1^c and 2^c of vacuum tubes 1 and 2 respectively are associated with inductances 34 and 35, respectively, and supplied with high voltage alternating current by means of the high potential secondary winding 19 of the transformer 7. Capacities 38 and 39 are connected in shunt to the inductances 34 and 35 for tuning the circuits to certain definite wave lengths. The grids 1^a and 2^a of tubes 1 and 2 are connected in parallel and the circuit coupled to coils 34 and 35 by means of the coil 36. Capacities 37 and 40 serve as radio frequency by-passes around the high voltage winding 19 of transformer 7. Capacity 63 serves as a radio frequency by-pass around the grid biasing resistance 4. The filaments 1^b and 2^b are heated by energy supplied by winding 20 of transformer 7. Coil 43 is coupled to the output coils 34 and 35 of the oscillating circuit. Electrodes connected to this coil 11 in any of the well known methods may be used for electrotherapeutic purposes. This circuit supplies radio frequency oscillations modulated at double the frequency of circuits shown in Figures 1, 2 and 3.

Figure 5 illustrates a method of using polyphase alternating current as plate supply to vacuum tubes 1, 2 and 3. The low frequency transformer 7 in this diagram consists of the primaries 16, 17 and 18, and the high voltage secondaries or plate supplied windings 44, 45 and 46 connected with plate electrodes 1^c, 2^c and 3^c. The filament currents for heating filaments 1^b, 2^b and 3^b are supplied by the step down transformer 51 having secondary 20 which may be an integral part of the polyphase transformer if desired. Capacities 48, 49 and 50 prevent coil 52 from shorting the secondary, or high voltage windings 44, 45 and 46. These capacities have one common terminal connected to the tuned circuit consisting of inductance 52 and capacity 53. The grids 1^a, 2^a and 3^a of tubes 1, 2 and 3 are connected in parallel and to the coil 36, which provides means of coupling between the output and input of the tubes. Capacity 63 is a radio frequency bypass around the grid biasing resistance 4.

Electrodes may be connected to the terminals of coil 43 coupled to the output circuit 52 and the high frequency current used in any of the well known methods of bodily treatment.

The operation of the circuits is as follows: In Figure 1 the transformer 7 is supplied with a source of low frequency commercial alternating current. The filament is heated to incandescence by current supplied from winding 20 of transformer 7. Positive and negative voltages are alternately impressed on the plate element 1^c of the tube. Only on the positive half of the cycle is the tube operative. Under these conditions, local oscillations are produced and sustained by means of the couplings between coils 36 and 8. A resonance voltage across inductance 8 will rise to such a value at the electrode terminals as to produce what is known as the Tesla current effect.

In Figure 2 the high frequency oscillations are sustained by means of the capacity coupling ratios of condensers 24 and 25. The voltage at electrodes 28 and 29 can be varied by adjusting the secondary turns of transformer 11.

In Figure 3 the associated circuit with tube 1 oscillates at its natural period determined by inductances 36 and 30 and associated capacities. These high frequency oscillations are impressed on the grid 14^a of tube 14 and hence modulates the low frequency plate current. The circuit associated with tube 14 increases the amplitude of the oscillations developed by tube 1. The amplified high frequency current at secondary terminals of transformer 11 is adaptable for eelctrotherapeutic treatments.

The circuit in Figure 4 oscillates at a frequency determined by the inductance and the capacity of the output circuits 35, 39, 34 and 38. Oscillations are sustained by means of the coupling between the grid coil 36 and coils 34 and 35. Radio frequency oscillations will be modulated at double the frequency of the plate supply. The output delivered to the therapeutic electrodes may be varied by changing the coupling between coil 43 and the coils 34 and 35.

In Figure 5 oscillations are sustained by the coupling between grid coil 36 and output coil 52. Energy delivered to electrodes through coil 43 may be varied by changing the coupling between coils 43 and 52. There will occur an overlapping of low frequency modulations so that a sustained high frequency oscillation will result. The oscillations developed in the electron tube circuits have such a frequency that no bodily sensation is produced other than diathermic.

While we have described our invention in certain specific embodiments, we do not intend any limitations beyond the scope of the appended claims.

What we claim is:

1. An electrotherapeutic apparatus comprising in combination a source of alternating current of relatively low frequency, a thermionic electron tube having an anode, cathode and grid electrode, an input circuit including said cathode and grid electrode, an output circuit including said anode and grid electrode, said circuits being electrically interlinked for the production of alternating current of relatively high frequency at which no bodily sensation is produced other than diathermic and a high frequency electrode connected with said output circuit for impressing said high frequency currents on the body of a patient.

2. An electrotherapeutic apparatus comprising in combination a source of alternating current of relatively low frequency, a thermionic electron tube, having a cathode, anode and grid electrode, an input circuit interconnecting said cathode and grid electrode, an output circuit interconnecting said anode and grid electrode, a transformer having primary and secondary windings, with its primary winding connected with said source of alternating current and its secondary winding connected between said anode and cathode, said input and output circuits being electrically coupled for increasing the frequency of the alternating current derived from said source to a frequency at which no bodily sensation is produced other than diathermic, and a high frequency electrode connected with said output circuit for impressing said high frequency current on the body of a patient.

3. An electrotherapeutic apparatus comprising in combination a source of polyphase low frequency current, a plurality of electron tubes each having a cathode, anode and grid electrode, said tubes corresponding in number with the number of phases of said low frequency current, means for impressing one phase of said polyphase source upon each of said anodes, and a circuit interlinking said grid electrodes with each of said anodes for increasing the frequency of said source to a frequency at which no bodily sensation is produced other than diathermic, a high frequency electrode, and means common to each of said anodes for impressing high frequency currents upon said high frequency electrode for application to the body of a patient.

4. An electrotherapeutic apparatus comprising in combination a source of relatively low frequency alternating current, an electron tube having cathode, anode and grid electrodes, a connection between said anode and cathode to said source of low frequency alternating current, a circuit interlinking said grid and cathode for increasing the frequency of said source of relatively low frequency alternating current to a frequency at which no bodily sensation is produced other than diathermic, and a high frequency electrode connected with said anode whereby high frequency energy may be impressed upon the body of a patient.

5. An electrotherapeutic apparatus comprising in combination a source of relatively low frequency alternating current, a plurality of electron tubes each having cathode, anode and grid electrodes, a transformer including a primary winding and a plurality of secondary windings, an input circuit including each of said grid electrodes, a pair of output circuits independently connected with each of said anodes, one of said secondary windings being arranged to heat the cathodes of all of said tubes and the other of said secondary windings being arranged to supply current to each of said independent output circuits, a connection between said input circuit and a point on said first mentioned secondary winding for deriving a negative bias for said grid electrodes, said input and output circuits being mutually electrically coupled for the generation of oscillations at a frequency at which no bodily sensation is produced other than diathermic, and means coupled with said output circuits for impressing said high frequency oscillations upon the body of a patient.

6. An electrotherapeutic apparatus comprising in combination a source of relatively low frequency alternating current, a plurality of electron tubes each having a cathode, anode and grid electrode, an input circuit interconnecting said cathodes and said grid electrodes, independent output circuits interconnecting said anodes and cathodes, each of said circuits including an inductance, said inductances being electromagnetically coupled, means for impressing said alternating current on each of said output circuits for actuating said electron tube circuits for the multiplication of the frequency of the source to a frequency at which no bodily sensation is produced other than diathermic, and an inductance electromagnetically coupled with said aforementioned inductances for transferring the high frequency oscillations thus produced to the body of a patient.

GLENN W. CARPENTER.
WENDELL L. CARLSON.

Aug. 2, 1927. B. F. JANCKE 1,637,448

AIR PURIFYING DEVICE

Filed Jan. 31, 1923

Fig. 1.

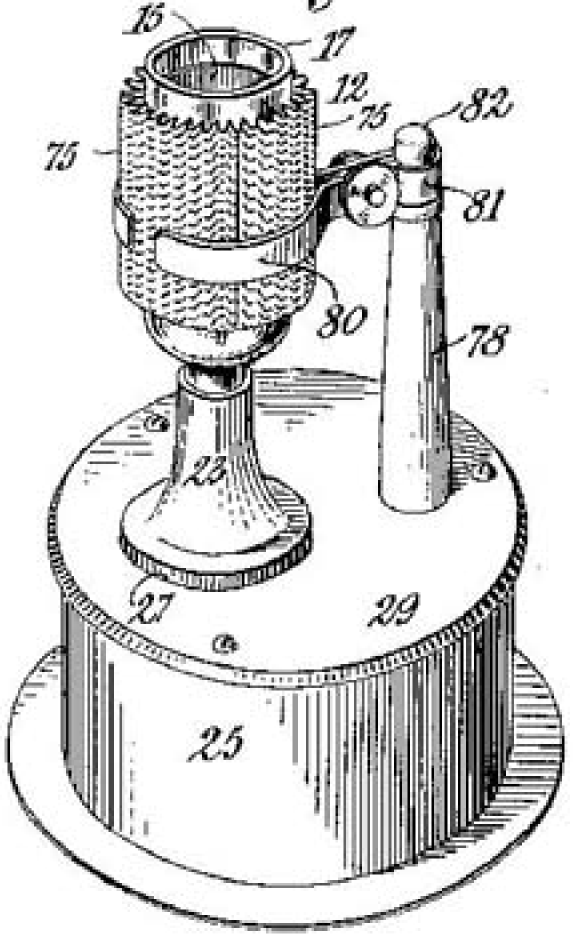


Fig. 2.

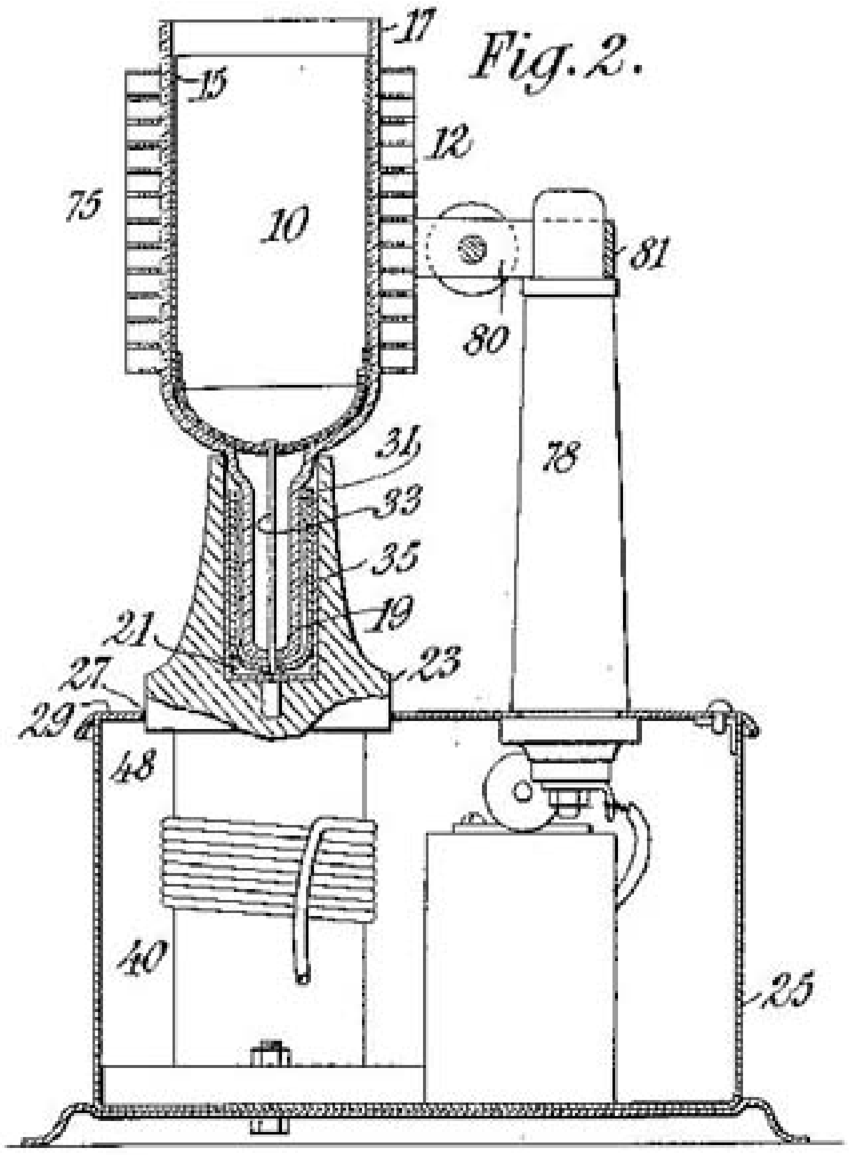


Fig. 3.

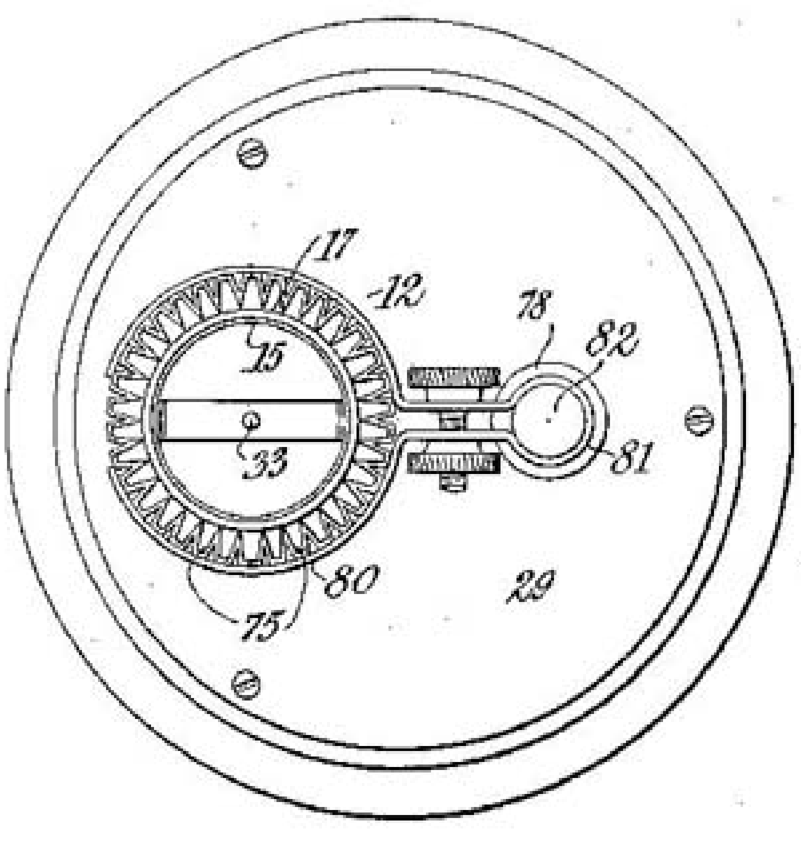
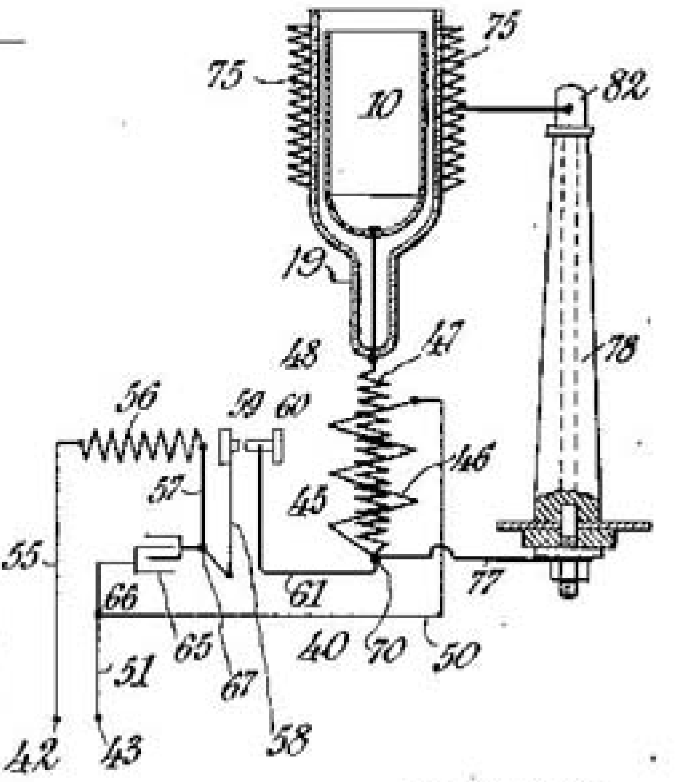


Fig. 4.



INVENTOR :

Benno Frederick Jancke,

By Attorneys,

Fraser Turk & Myers

Patented Aug. 2, 1927. **1,637,448**

UNITED STATES PATENT OFFICE.

BENNO F. JANCKE, OF BROOKLYN, NEW YORK, ASSIGNOR, BY MESNE ASSIGNMENTS, TO HALLIWELL-SHELTON ELECTRIC CORPORATION, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

AIR-PURIFYING DEVICE.

Application filed January 31, 1923. Serial No. 616,092.

This invention relates to air purifying devices producing ozone, and provides improvements therein.

The present invention provides a simple, inexpensive, and efficient device for use in chambers such as sick-rooms, crowded rooms, salons, ice boxes, refrigerators, telephone and talking machine booths, or the like, for purifying the air therein by the generation of ozone and also preferably by lading the air with ozonized medicated vapor or with an odorament, or the like, the volatilization or gasification of which is assisted by the heat produced by the diffused high tension discharge of the ozone generator.

It further provides an apparatus having means for producing a high-frequency current in the discharge circuit thereby making the apparatus safe for use where persons are apt to come into contact with the apparatus.

An embodiment of the invention is illustrated in the accompanying drawings, in which—

Figure 1 is a perspective view of the device.

Fig. 2 is a vertical sectional view through the apparatus.

Fig. 3 is a top plan view, and

Fig. 4 is a diagrammatic view showing the electrical ensemble.

Referring to said drawings, numeral 10 designates an electrode and 12 another electrode or a suitable capacity, between which electrode and capacity an electrical discharge is adapted to be produced for acting on the air to convert the oxygen thereof to ozone. The electrode 10 is preferably in the form of a cup or receptacle, adapted to contain a medicament (liquid or solid) or odorament, or the like, vaporization of which will be assisted by the heat produced by the electrical discharge at the electrode. In practice the electrode 10 is conveniently in the form of a metallic tube 15 within a dielectric such as glass 17, in the form of a cup or vase, and having a contracted end 19 adapted to fit in a socket 21 in a pedestal 23, which later, as here shown, may be attached to a casing 25 for certain of the electrical parts, and may project through an opening 27 in a top or cover 29 of said casing. On the contracted end 19 of said cup 17 there is a metal thimble 31, which is connected to the tube 15 on the inside of the cup 17 by a wire 33 passing through a seal in the glass cup 19. A similar metal thimble 35 is placed in the socket 21, in which the end 19 of the cup with its thimble 31 thereon, constituting a plug, is adapted to make contact, the parts just described constituting a slip-joint plug and socket electrical connection between the cup 17 and pedestal 23.

40 designates the parts for generating the high-frequency high-tension current employed, these parts being conveniently housed in the casing 25, and the current for energizing is preferably taken from the lighting circuit through the terminals 42, 43, Fig. 4. As the apparatus is relatively small and self-contained, and may be connected to any of the outlets of a household lighting circuit, it is portable and readily adapted for household use.

The generating apparatus comprises a transformer or resonator 45 having a primary 46 and a secondary 47, which latter is connected to the electrode 10, as indicated at 48, being immediately connected to the thimble 35 in the socket 21. The primary is connected to one of the terminals 43 by way of conductors 50, 51, and to the other terminal 42 by way of conductor 55, inductance 56, conductors 57, 58, interrupter 59, contact 60, and conductor 61. Shunted across the leads to the primary, and in resonance therewith, is a condenser 65, connected to conductors 51 and 57 as indicated at 66, 67.

The secondary 47 is grounded conveniently on one of the primary leads as indicated at 70.

When a connection is established through the terminals 42, 43 with a lighting circuit, current flows from terminal 42 through conductor 55, inductance 56, conductors 57, 58, armature or interrupter 59, contact 60, conductor 61, and primary 46, and conductors 50 and 51 to terminal 43. When the armature or interrupter 59 is drawn away by the electromagnetic effect of the coil 56, a short spark is produced between the armature 59 and contact 60, thereby setting up a high-frequency oscillation from the condenser 65. These high-frequency oscillations passing through the primary 46 produce a high electromotive force in the secondary 47, which is sufficient to overcome the dielectric effect of the glass 17, causing a discharge between the electrode 10 and capacity 12. The capacity 12 is conveniently in the form of a metal tube 75 surrounding the electrode 10, and connected to ground or a body of large capacity (such as the dynamo and lighting circuit) by being connected to one of the primary leads, as indicated at 70, through a conductor 77 and the metallic parts of a post 78 from which the capacity 12 is supported. In order to increase spark area, the tube 75 is preferably provided with many points, or spiculated, thereby producing a great number of sparks, and a high rate of ozone generation. The tube 75 is moreover preferably divided into two or more segmental parts, so as to be readily put in place around the glass 17, and removed, and is held together by a clamp 80 having an arm 81 fitting in a metal knob 82 in the post 78.

The ozone will purify the air, and increase the activity of the oxygen thereof, and the medicament or odorament, which will be volatilized by the heat of the electric discharge, may also purify the air or medicate or sterilize it.

If a part of the body is brought into contact with or close to the electrode 10, the discharge to the body will not be injurious or highly disagreeable, owing to the high frequency of the current employed, which is over 10,000 oscillations per second, and may be, for example, about 60,000 oscillations per second.

The inventive ideas may receive other embodiments than that herein specifically illustrated and described.

What I claim is:—

1. An air purifying device, comprising electrodes adapted for the production of ozone, one of said electrodes comprising a liquid receptacle adapted to be heated by the discharge from said electrodes, whereby liquid contents thereof may be volatilized.

2. An air purifying device, comprising electrodes adapted for the production of ozone, said electrodes being substantially coextensive throughout their areas, one of said electrodes comprising a liquid receptacle adapted to be heated by the discharge from said electrodes, whereby liquid contents thereof may be volatilized.

3. An air purifying device, comprising electrodes adapted for the production of ozone, said electrodes being substantially coextensive throughout their areas, one of said electrodes comprising a liquid receptacle adapted to be heated by the discharge from said electrodes, whereby liquid contents thereof may be volatilized, a rigid dielectric separating said electrodes and the other of said electrodes being in the form of a split cylinder surrounding said dielectric.

4. An air purifying device, comprising electrodes adapted for the production of ozone, said electrodes being substantially coextensive throughout their areas, one of said electrodes comprising a liquid receptacle adapted to be heated by the discharge from said electrodes, whereby liquid contents thereof may be volatilized, a rigid dielectric separating said electrodes and the other of said electrodes being in the form of a split cylinder surrounding said dielectric, and a clamp for holding said cylinder parts together on said dielectric.

5. An air purifying device, comprising electrodes adapted for the production of ozone, said electrodes being substantially coextensive throughout their areas, one of said electrodes comprising a liquid receptacle adapted to be heated by the discharge from said electrodes, whereby liquid contents thereof may be volatilized, a rigid dielectric separating said electrodes and the other of said electrodes being in the form of a split cylinder surrounding said dielectric, a clamp for holding said cylinder parts together on said dielectric, and a ground attachment, said clamp being fastened on said ground attachment.

6. An air purifying device for chamber use, comprising an exposed electrode adapted for the production of ozone, and means for producing high frequency high potential differences at said electrode, whereby a high potential heating and discharge current without dangerous effect on the human system may be produced at said electrode.

7. An air purifying device for chamber use, comprising an exposed electrode adapted for the production of ozone, means for supplying said device with current from a lighting circuit, and means for transforming said current to one of a high voltage and high frequency at said electrode, whereby a high potential heating and discharge current without dangerous effect on the human system may be produced at said electrode.

8. An air purifying device adapted for the production of ozone, comprising a pair of substantially cylindrical spaced electrodes, the surface of one of said electrodes being multi-pointed.

9. An air purifying device adapted for the production of ozone, comprising a pair of substantially cylindrical spaced electrodes, one of said electrodes being in the form of a liquid receptacle and the other of said electrodes having a spinose surface.

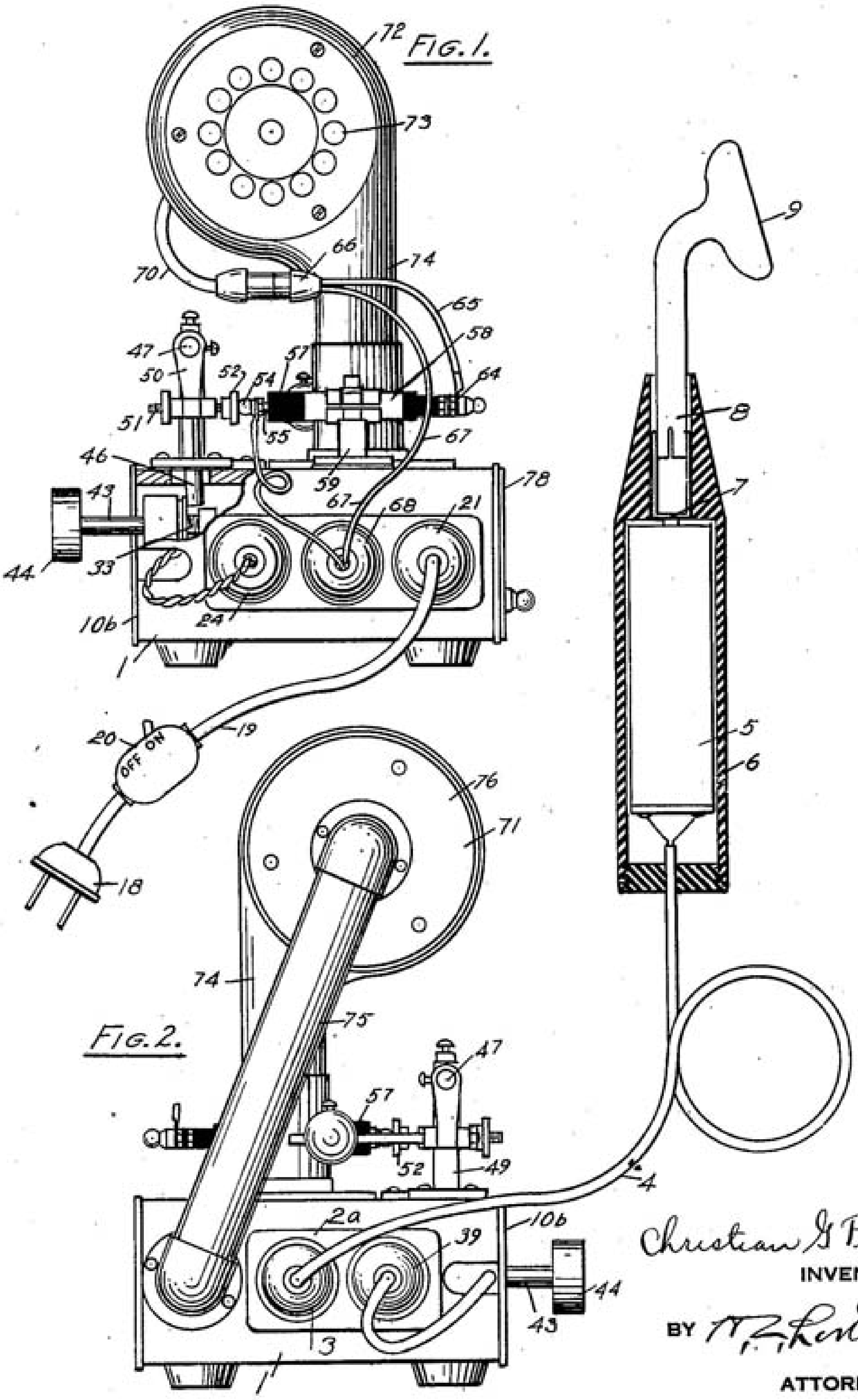
In witness whereof, I have hereunto signed my name.

BENNO F. JANCKE.

July 6, 1943. **C. G. FILZER** **2,323,529**

APPARATUS FOR VIOLET RAY TREATMENT

Filed Dec. 26, 1939 3 Sheets-Sheet 1



Christian G Filzer
INVENTOR

BY

ATTORNEYS

July 6, 1943. C. G. FILZER 2,323,529

APPARATUS FOR VIOLET RAY TREATMENT

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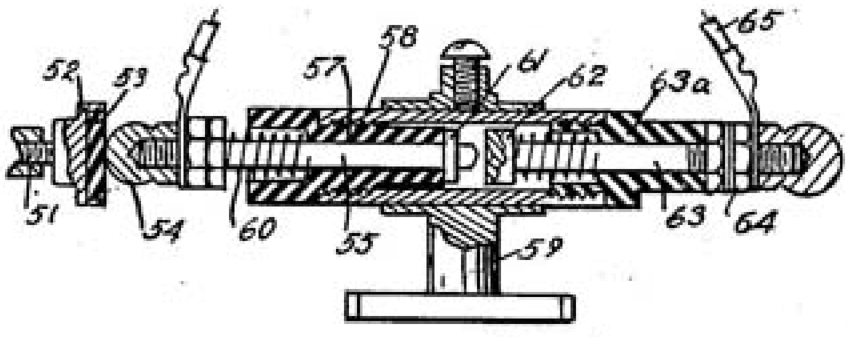

FIG. 4.

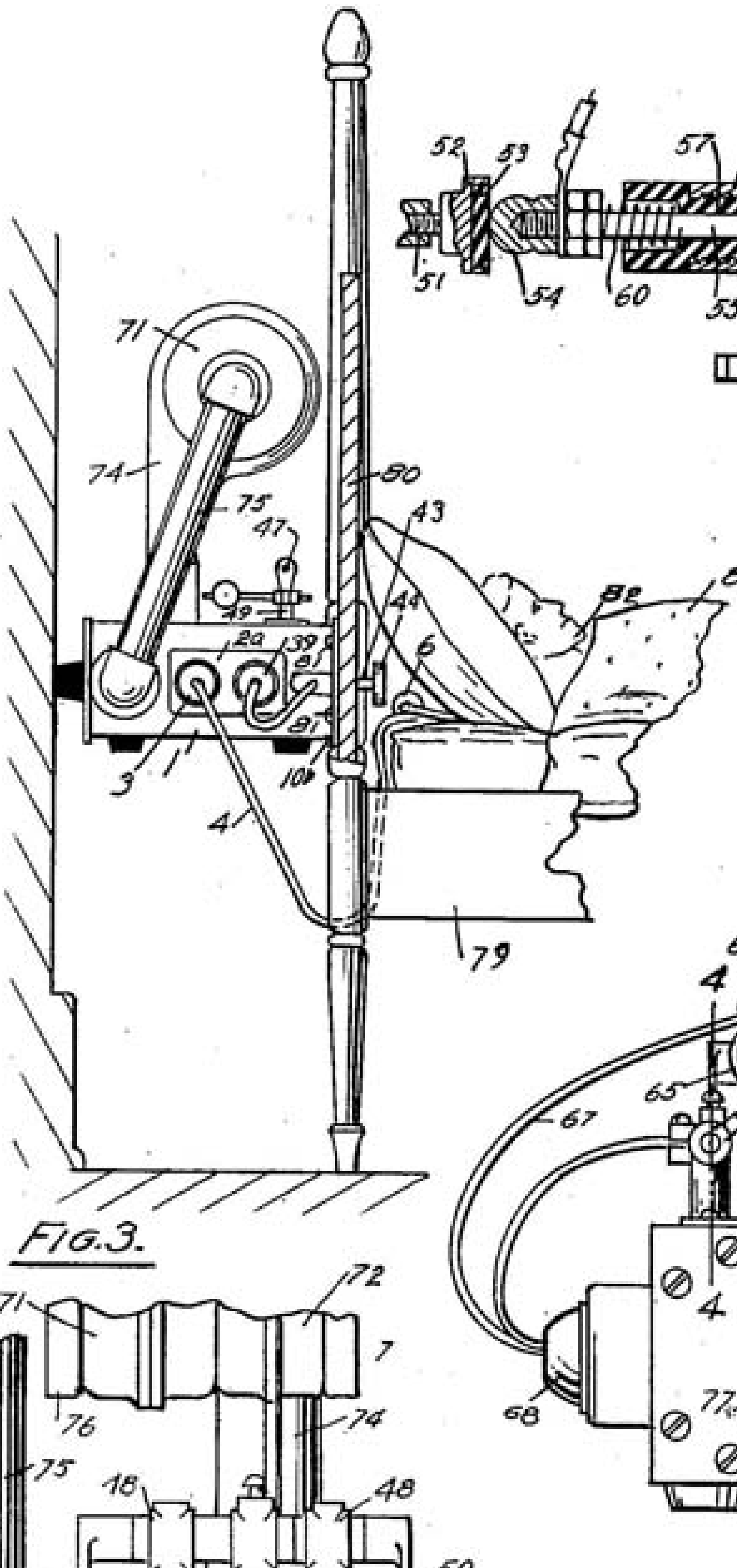

FIG. 3.

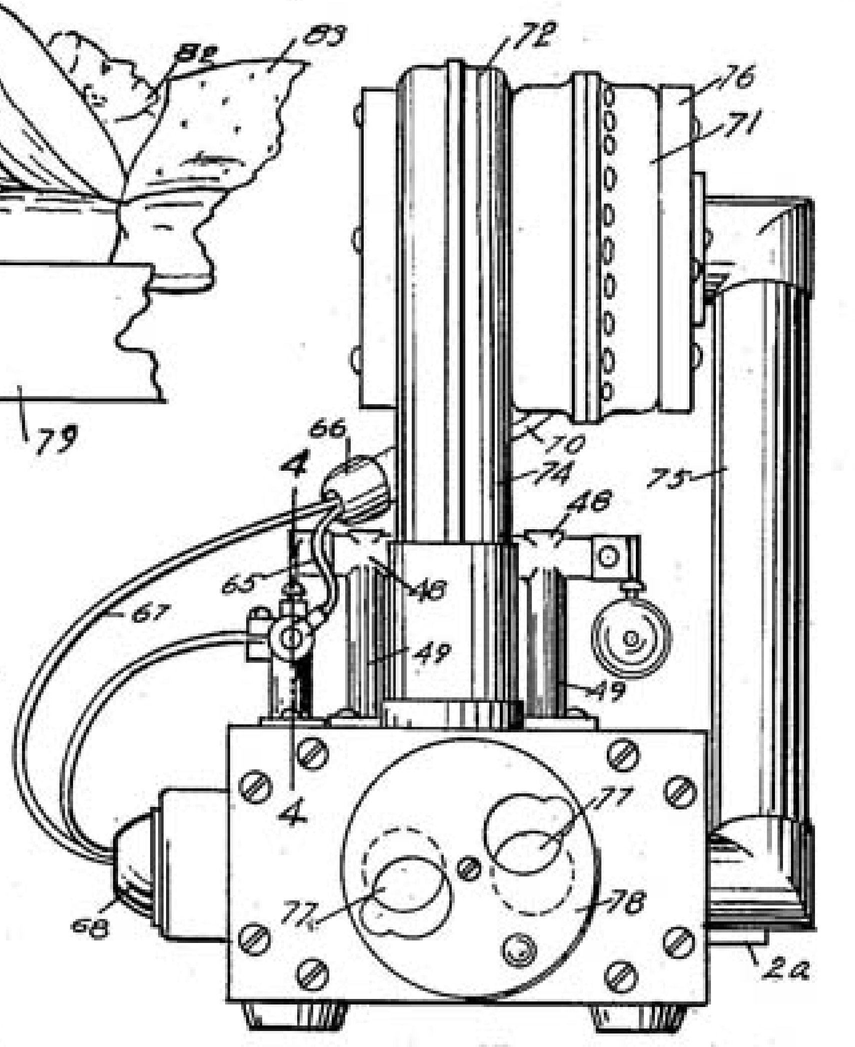

FIG. 5.

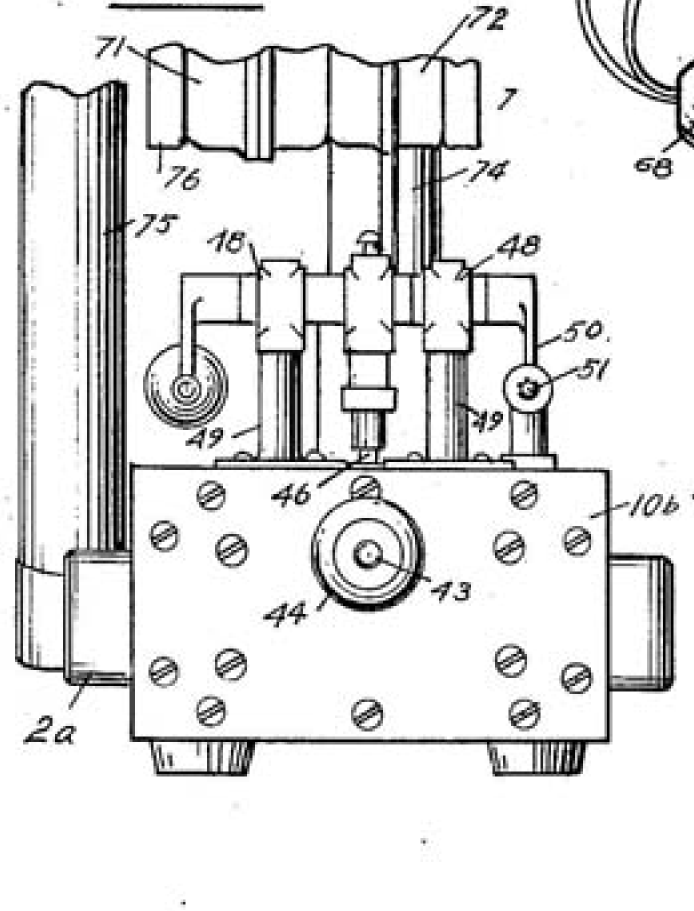

FIG. 6.

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July 6, 1943. C. G. FILZER **2,323,529**

APPARATUS FOR VIOLET RAY TREATMENT

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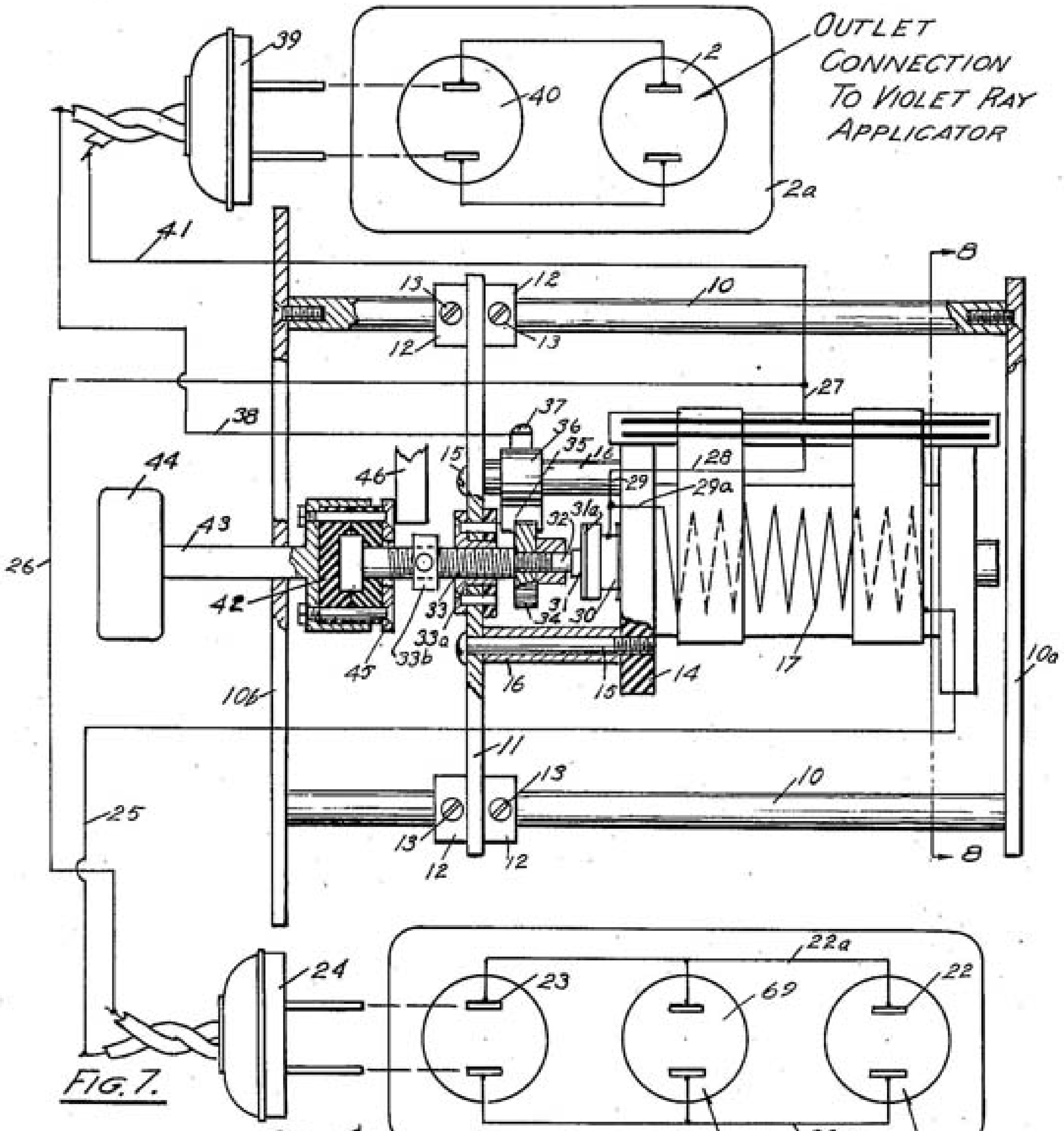

FIG. 7.

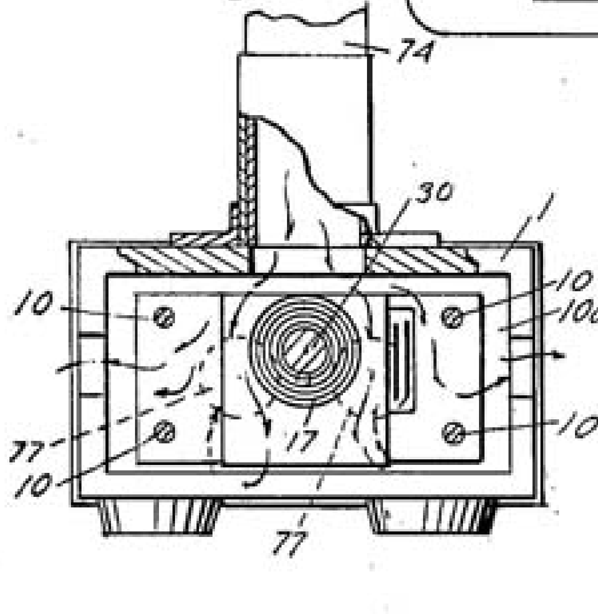

FIG. 8.

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Patented July 6, 1943 2,323,529

UNITED STATES PATENT OFFICE

2,323,529

APPARATUS FOR VIOLET RAY TREATMENT

Christian G. Filzer, Erie, Pa.

Application December 26, 1939, Serial No. 310,936

5 Claims. (Cl. 175—363)

The present invention is designed to improve violet ray apparatus and also involves an arrangement of said apparatus in connection with means improving the application of the ray and the method of such use.

In carrying out the invention I provide a case or enclosure for the coil, condenser and immediately associated parts and provide a fan which is connected with such enclosure by means of which circulation of air may be continued through the enclosure. This is important generally, but particularly important in connection with the treatment which also forms the subject matter of the invention.

The invention also involves a common control for the fan, motor and the ray apparatus so that with a single control there is put into operation the different phases of the apparatus in proper sequence.

The invention also involves a proper enclosure and a use of the ray so as to maintain the ozone created by the ray in contact with the portions of the body which may be under treatment. Features and details of the invention will appear from the specification and claims.

A preferred embodiment of the invention is illustrated in the accompanying drawings as follows:

Fig. 1 shows a side elevation.

Fig. 2 a similar view from the opposite side of the apparatus.

Fig. 3 a side elevation showing the apparatus mounted on a couch and the manner of treatment with the apparatus so arranged.

Fig. 4 a sectional view of the controlling switch.

Fig. 5 a rear elevation of the apparatus.

Fig. 6 a front elevation of the apparatus.

Fig. 7 a sectional view of the case with parts removed to show the connections and wiring.

Fig. 8 a sectional view of the case along the line 8—8 in Fig. 7.

1 marks the case. This is provided with a switch socket 2 arranged on a plate 2a on the side of the case. A plug 3 is arranged in the switch socket 2. A cord 4 extends from the plug 3 to the resonance coil 5, the resonance coil being placed in a tube from the handle for the applicator. The coil is connected through an electrode 7, extending into tube 8, which terminates in an applicator 9. These are of common construction.

The frame of the device has four rods 10 from front to rear, these being connected with a rear plate 10a and a front plate 10b. A bridge plate 11 is secured to the rods 10 by means of collars 12 secured in place by set screws 13. A frame block 14 is secured to the rear of the bridge plate 11 by screws 15, distance sleeve 16 being arranged between the block 14 and the plate 11. The usual magnetic coil 17 is carried by the block 14.

A plug 18 is provided to connect the apparatus to a supply current. A core 19 extends from the plug 18 and is provided with the usual switch 20. This plug terminates in a switch-plug 21 which is adapted to connect the current to and from a socket 22 arranged on a plate 1a on the case. The socket 22 is connected by connecting bars 22a with a socket 23. A plug 24 is placed in the socket 23, and one line 25 from the plug leads to the magnetic coil 17. The opposite line extends from the plug through a wire 26, 27, 28, 29, and 29a, to the opposite side of the coil. A cord 30 of the coil operates in connection with a vibrator plate 31 carried by spring arm 31a and a contact 32 carried by a controlling rod 33 which is screw-threaded through a nut 33a in the bridge plate.

A click wheel 34 is arranged on the adjusting rod and operates with relation to a spring clip 35 arranged on a collar 36. A set screw 37 is provided for the collar, the set screw also providing a connection for wire 38, the wire 38 extending to a switch plug 39 which plug is adapted to operate in connection with a socket 40 on the plate 2a. The socket 40 is connected with the socket 2 and with the connections heretofore described leading from them to the resonance coil. The return wire 41 from the socket 40 and plug 39 connects with the wire 27 and also with the vibrating plate 31. The connection is established, therefore, through the click wire 38 and the return circuit described through the vibrator.

The control rod 33 is connected through an insulating block 42 with a rod extension 43 which has an operating knob 44. By operating the knob 44 the contact 32 may be advanced or retracted so as to initially make the vibrator active and then to vary its adjustment to vary the intensity of the ray. A stop collar 33b is provided to limit the inward movement of the rod at its innermost adjustment.

In the present invention the controlling rod with its knob also controls the switch mechanism which sets the apparatus in operation. A plate 45 is arranged on the face of the insulating block 42. A rock arm 46 engages the face of this plate and consequently is swung as the rod is moved inwardly through the screw threaded connection of the rod as the rod is advanced, making the

W. L. CARLSON AND E. C. HANSON.
ELECTROTHERAPEUTIC APPARATUS.
APPLICATION FILED JULY 12, 1919.

1,338,812. Patented May 4, 1920.

Fig. 1.

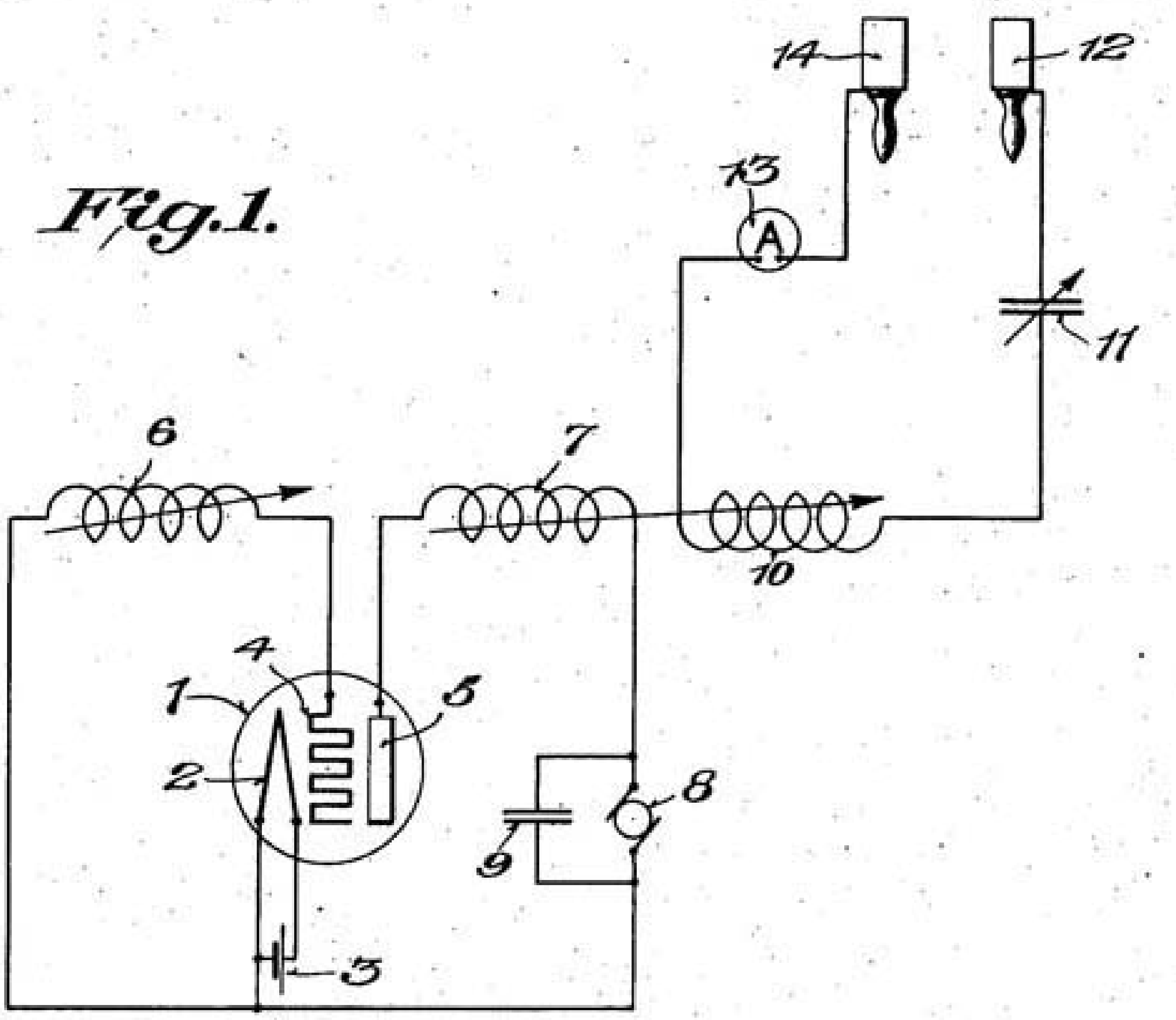


Fig. 2.

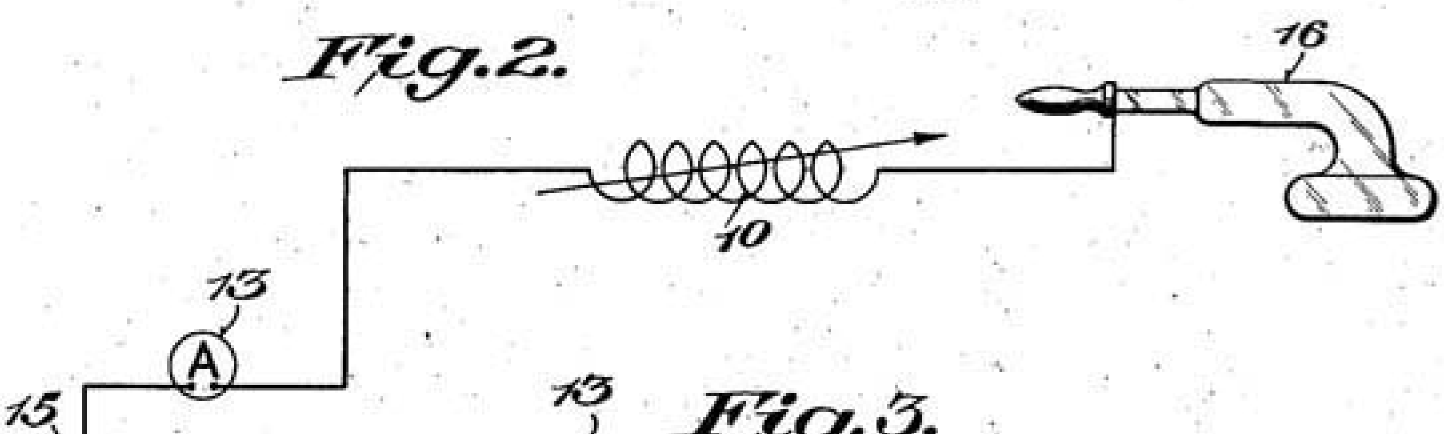
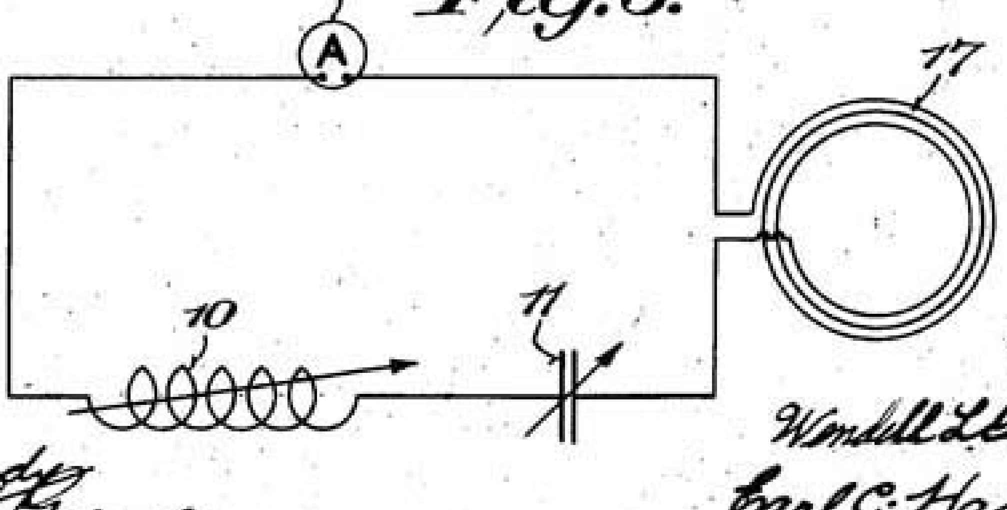


Fig. 3.



Witness
E.B. Brady
Chas. L. Griesbauer

Inventor
Wendell L. Carlson.
Carl C. Hanson

(2 SHEETS)

SHEET 2.

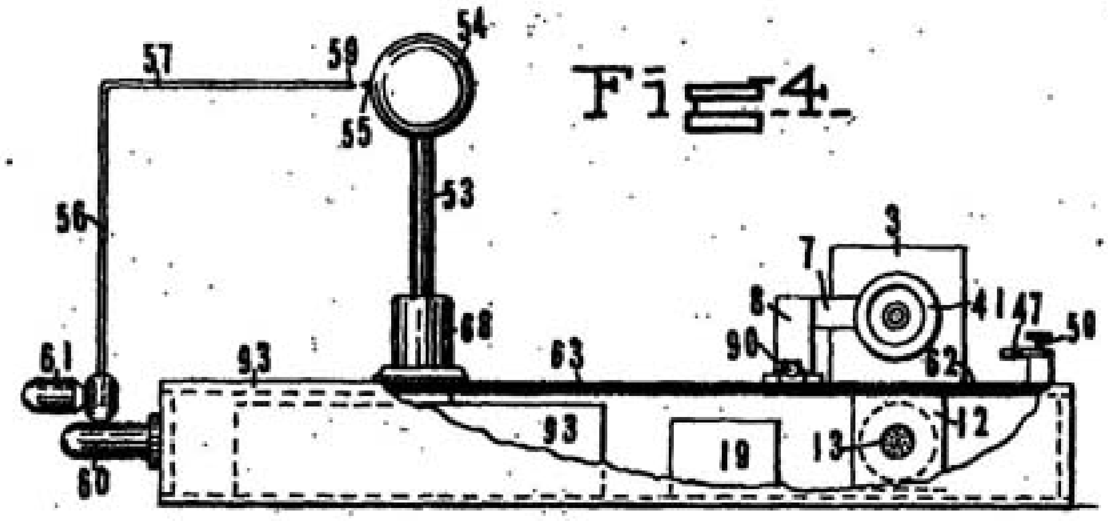


Fig 4.

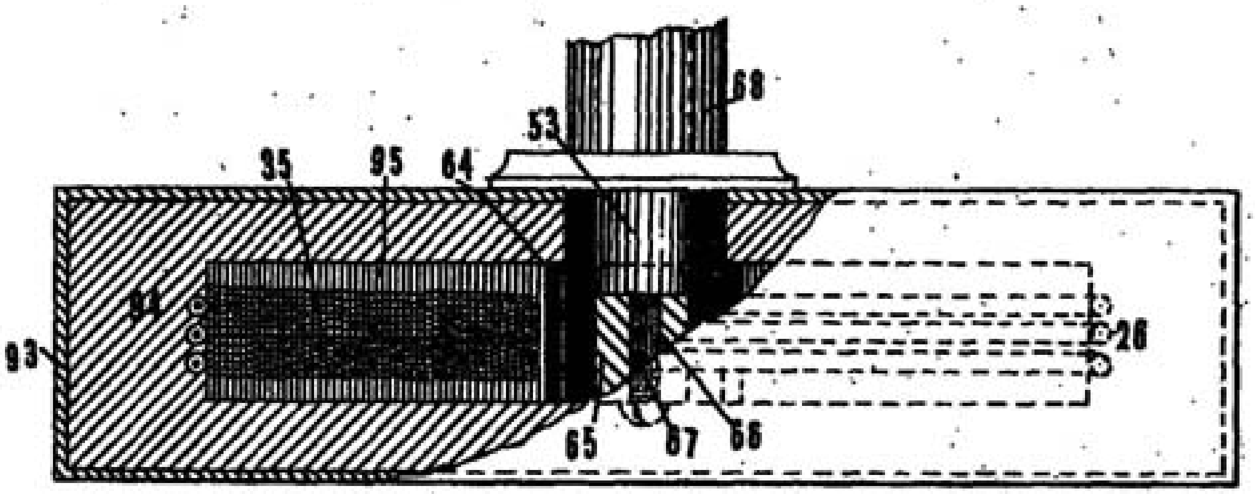


Fig 5.

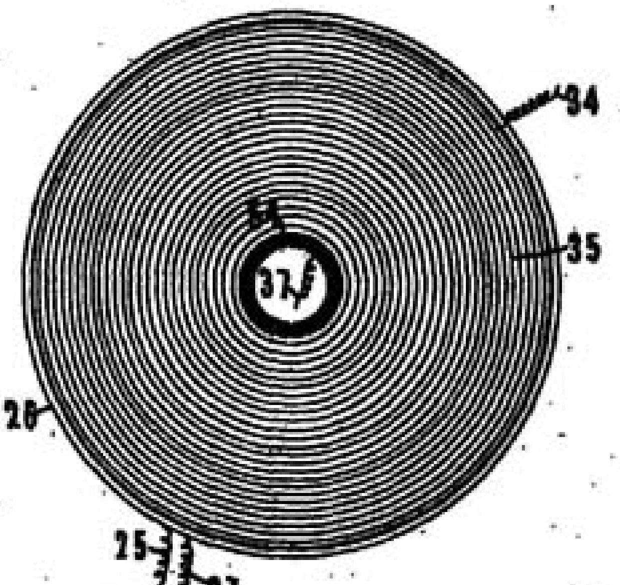


Fig 6.

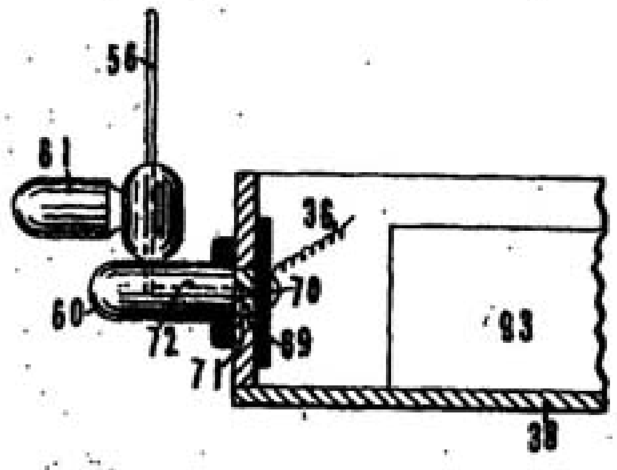


Fig 7.

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means, and an interrupter operated by said armature. Said electro-magnetic device is preferably wound with two coils 14, 15, the wires of which may be side by side.

The switch 9 comprises pivoted conductor arms 16, 17, and 18, and suitable insulating and operating means therefor. The arms 16, 17 are connected by wires 19, 20, with opposite ends of the coil 14 and in the position of the switch shown in full lines in the drawing which is that for operation with an alternating current, these arms contact with terminals 21, 22, one of which, 21, is connected to one side of the switch 11, which is assumed to be a double pole switch, and the other of which, 22, is connected through rheostat 10 to the other side of said switch 11, thus establishing a supply connection from the line wires 2, 3, to the coil 14; said circuit leading from wire 2 through one side of the switch 11, wire 23 to terminal 21, switch arm 16, wire 19, coil 14, wire 20, switch arm 17, terminal 22, wire 24, rheostat 10, wire 26, and the other side of switch 11 to the line wire 3. Coil or winding 15 is at the same time energized by a parallel connection including the interrupter or circuit breaker, two of whose terminals 28, 29, are connected by a spring 36, also serving as a conductor, to the armature 13 aforesaid, the other terminals 30, 31, being fixed and being connected respectively by a wire 32 to the outgoing side of switch 11 and by wires 33, 34, to arm 18 of switch 9, from which the connection is completed by the terminal 39, wire 25 and coil 15 to wire 24 at the other side of the circuit as hereinafter described. In this position of the switch, therefore, there is a connection from the line through coil 14 of the electro-magnetic device for causing the control or operation of said device and of the interrupter operated thereby in response to the alternations of the alternating current and there is a parallel connection through the coil 15 and through the interrupter for producing the interruptions of the inductance circuit necessary for the setting up of the high potential impulses which charge the condenser.

When the switch 9 is moved to the position shown in dotted lines, the arm 16 breaks circuit and the arm 17 makes contact with the terminal 27 connected by wire 25 to one end of the coil 15, whose other end is connected to wire 24 aforesaid, and through the rheostat and wire 26 to the return side of switch 11. Under these circumstances the connection from the line to the electro-magnetic device is through the interrupter aforesaid.

In the position of the switch 9, last referred to, arm 18 is in contact with a terminal 35 connected to wire 19. This is the position for operating with direct current, the circuit leading from wire 2, through switch 11 to wire 32, terminals 30 and 28, connection 36 on the armature, terminals 29, 31, wires 33 and 34, switch arm 18, terminal 35, wire 19, coil 14, wire 20, switch arm 17, terminal 27, wire 25, coil 15, wire 24, rheostat 10, and wire 26 to the other side of the line switch 11. Thus, in this position of the switch 9, the two energizing coils 14, 15, are placed in series and the interrupter is included in the circuit, whereas in the full line position the two coils are in parallel and the connection to one of them does not include the interrupter. The condenser circuit comprises the wire 33 leading from the terminal 31, aforesaid, to one side of the condenser 4 and a wire 37 leading from the other side of the condenser to the coil 5 whose other end is connected by wire 38 to the terminal 30. The wires 33, 37, 38, coil 5, and, generally the connections of the condenser circuit should be of large cross section so as to present a minimum resistance, and said wires and coil are preferably formed of conducting tubes, to lessen the inductance thereof.

In order to charge the condenser it is necessary to maintain a connection therewith from the electro-magnetic device 1. This connection in the dotted position of the switch 9 is established by the arm 18 making contact with the terminal 35; and in the full line position of the switch by said arm making contact with the terminal 39 connected to wire 25 aforesaid.

One of the energizing circuits of the electro-magnetic device being independent of the interrupter when the apparatus is supplied by alternating current, the armature, will, at such times, tend to operate responsively, or in synchronism with the alternations of such current and to insure complete synchronism, means are provided for regulating the periodicity of vibration of said armature; such means may consists of an elastic support, such as a ribbon 40 having means for adjusting its tension, being, for example, stretched between a fixed support 41 and a rotatable support 42, the latter of which is provided with adjusting means such as an arm 43 and set screw 44, for adjusting its angular position and thereby varying the tension of the ribbon 40 so that the free vibration of the armature under the influence of its weight and of said tension will correspond with the frequency of the alternating current being used. It is desirable that the apparatus should be so placed that the ribbon 40 stands "on edge" to allow the heat from the contacts to be carried off by the ascending air currents.

The terminals 30, 31, of the interrupter may be formed as screws to permit adjustment thereof. The object of providing the two sets of terminals 28, 30, and 29, 31, is to give the effect of a long break with relatively small travel of the interrupter.

In using the apparatus with direct current, the switch 9 is placed in dotted line position and the charging current passes through the said switch, through the interrupter, the electro-magnetic device 1 and the rheostat in the manner above set forth, thereby causing the interrupter to be vibrated and repeatedly interrupting the charging current. At each interruption there is a sharp rise of potential between the two sides of the circuit owing to the kick of self-inductive impulse of the electro-magnetic device. This impulse is transmitted to the condenser passing, for example, from line 2, switch 11, wires 32, 38, coil 5, wire 37 to condenser 4, the connection leading from the other side of the condenser through wires 33, 34, arm 18, wire 19, coil 14, wire 20, arm 17, wire 25, coil 15, wire 24, rheostat 10, wire 26, and switch 11 to line 3; the two coils 14, 15, thus being in series and exerting their combined effect in charging the condenser. As soon as this self-induction impulse has reached its maximum and has correspondingly charged the condenser, the potential in the electro-magnetic device will begin to fall and the condenser will begin to discharge through the condenser circuit and coil 5. At this moment, or immediately thereafter, the interrupter will close a condenser discharge circuit at the terminals 28, 30, 29, and 31, the discharge passing from the condenser through wire 33, contacts 31, 29, conductor 36, contacts 28, 30, wire 38, coil 5, and wire 37 to the other side of the condenser. This discharge circuit will be of extremely low resistance as it does not include any part of the charging coils 14, 15.

The primary inducing coil 5 is preferably formed with very few turns, thus decreasing the resistance to the minimum. Owing to the low resistance of this circuit, the oscillatory discharge therein will have a correspondingly high periodicity and high frequencies say, several hundred thousands per second, can be obtained. It is essential to this effect, that the interrupter should close contact, as near as possible, at the time of discharge so that the condenser will discharge upon a closing and not upon an opening contact, and the discharge circuit is thus of a minimum resistance.

When the apparatus is to be used with alternating supply circuits, the switch 9 is moved to the full line position so that the coil 14 will be energized from the line independently of the interrupter, so that the magnetic oscillations in the core 12 will be in correspondence with the alternating current. The coil 15 will also be energized from the line, in parallel with coil 14, and through the interrupter, and the elastic armature support 40 should be adjusted as above described so that the armature will freely vibrate in sychronism with the alternating current, and the coils 14 and 15 will operate in synchronism, the coil 14 serving to control the rate of vibration. The oscillations in magnetic flux in the core 12 result in corresponding electrical oscillations in the condenser circuit, which is connected to the ends of the coils 14 and 15, these impulses passing from line 2, through wires 32, 38, coil 5, wire 37, to one side of the condenser and from the other side thereof through wire 34, arm 18, wire 25, coil 15, wire 24, rheostat 10, and wire 26 to line 3. At the moment when the condenser has received a charge through this connection, the armature 13 allows the interrupter to close the circuit, thus establishing a discharge circuit for the condenser independent of the electromagnetic device 1, said discharge circuit leading from the condenser through wire 33, terminals 31, 29, conductor 36, terminals 28, 30, wire 38, coil 5, and wire 37 to the other side of the condenser. The change in connections made by the switch 9, in changing from direct to alternating current, serves, first, to cut out the interrupter from the supply connection for one energizing coil, so as to enable the alternating current to control the rate of vibration of the armature, and in the second place, to reduce the number of turns of windings in series in the energizing circuit by placing the two coils in parallel relation. This is necessary for the reason that in an alternating circuit, the mean or effective electro-motive force is, of course, much less than the maximum electro-motive force, so that in changing from direct to alternating current of the same nominal potential, the turns of winding must be decreased correspondingly to give the same magnetizing effect. In the form of winding shown, a copper tube or sheathing 45 may be provided to increase the time or lag period of the inductance coil.

Instead of winding the two coils 14, 15 on the same core as above described, they may be wound on separate cores. Thus in the embodiment of the invention shown in Figs. 2 and 3, coil 14 is wound on the core 12 of the interrupter operating member while the coil 15 is wound on a separate core 12^1 and serves as the inductance means for charging the condenser. Said coil 15 in this case is preferably divided into sections connected to contacts 46 engaged by a sliding contact 47 connected by its rail 48 and wire 24 to the terminal 22 of switch 9.

51 designates the enclosing box or case which may be provided with a cover or lid 52 hinged thereto.

The induction coil proper for transforming the discharge from the condenser into impulses of high voltage, is preferably enclosed in the lid or cover of the box, the primary coil 5 thereof being connected by flexible connections to the inducing apparatus in the box, and the secondary coils 6 being connected to posts 53 which extend through the top of the lid and are provided with slidable or adjustable discharge terminal-rods 7, 8, between which the discharge is to pass.

The interrupter comprises a contact 28 formed as an adjustable screw passing through a post 64, and a contact 30 carried by a support connected to be operated by the armature 13 of the magnet and comprising a ribbon 40 of an elastic material, such as steel, stretched between two supports 41, 42 on a supporting-plate 48^1, and carrying a bracket 49 to which is attached the armature 13, aforesaid, and also the contact-supporting member 50 which is formed as a spring-plate or leaf spring secured at its lower end to the bracket 49 and extending at its upper end alongside the upper end of the vertical arm of the bracket 49, but a little removed therefrom so that on attraction of the armature, said vertical arm will impinge against said spring-support and separate the contacts.

A depression 54 is formed in support 42 under the ribbon 40, and a lever 43 pivoted on the support 42 has a lug or bar 55 engaging said ribbon over said depression, the other end of said lever being engaged by a depression screw 44 whereby the lever may be depressed more or less to cause the bar 55 to press or bend the ribbon into the depression 54, thereby increasing the tension of the ribbon and the periodicity or frequency of vibration of the ribbon and attached parts to the required extent.

The induction coil preferably comprises two secondary coils 6, each substantially disk-shaped, with the outer edges of the disks substantially tangential or in close proximity, and the primary coil 5 surrounding both the said disk-coils and curved in or re-entrant at each side to conform substantially to the contour of the secondary coils. It is found that the best results are obtained by bringing the secondary coils closely together and extending the primary coils inward as far as possible between the secondary coils.

The secondary coils are wound spirally, the inner terminal of each secondary coil being connected to the corresponding terminal post 53, and the outer terminal of one of the secondary coils being connected to the outer terminal of the primary coil, while the outer terminal of the other secondary coil is connected to the inner terminal of the primary coil.

2, 3, designate binding posts or terminals for the supply connections which may supply either direct or alternating circuit.

The switch 11 operates as a reversing and main switch. The switch 9 comprises three switch arms 16, 18, 17, cooperating with the fixed contacts 35, 39, 22 and mechanically connected to move in unison, this switch serving to change the circuit connections for alternating and direct current operation; said switches being connected to the induction means, interrupter and condenser by wires 19, 20, 25, 26, 32, 33, 34, 37, 38, and the operation is the same as described in connection with Fig. 1, except that the inductive coil 15 and interrupter operating coil 14 operate on separate cores instead of on the same core.

The fact that the primary is made in one coil surrounding the two coils of the secondary, avoids the inductance of the connections that would have to be used with two separate primaries, thereby reducing the inductance of the discharge circuit to a minimum. The fact that the two secondary coils are side by side has the advantage over constructions where the coils are placed end to end, in that the mutual induction thereof is minimized.

An important application of the above described invention of discharge system is in connection with the production of light rays of special character, for example, violet rays

Having now particularly described and ascertained the nature of the said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. A discharge apparatus for the purpose set forth comprising self inductive and interrupter operating coils, a condenser connected to be charged by the self inductive coil, a discharge circuit for the condenser and an energizing circuit for the coils connected and arranged substantially as shown and described.

2. In a discharge apparatus as described in Claim 1 the switches in the supply or energizing circuit connected to the coils and adapted to connect the same alternatively for operation by direct or alternating current substantially as shown and described.

3. In a discharge apparatus as described in Claim 1 the construction wherein the self inductive and interrupter operating coils are wound on the same core (Fig. 1) or on separate cores (Figs. 2 and 3).

4. In an electrical discharge apparatus as described the charging connections for the condenser including a vibratory interrupter operated by the electro-magnetic induction device, an energizing connection for the induction device independent of the interrupter for control thereof by alternating current, and means for adjusting the rate of vibration of said interrupter.

5. In an electrical apparatus for the purpose described the arrangement of the circuits, comprising one including the self-inductive coil, the interrupter operating magnet and the interrupter, in series, a second circuit including the interrupter operating magnet exclusive of the interrupter, a third circuit including the self-inductive coil and the interrupter, exclusive of the interrupter operating magnet, and a discharge circuit including the condenser, the primary of the induction coil and the interrupter.

6. In an electrical apparatus for the purpose described having an induction coil comprising two secondary coils side by side, and a primary coil surrounding both the secondary coils the arrangement wherein the outer ends of the secondary coils are connected to the ends of the primary coil, and discharge electrodes are connected to the inner ends of the secondary coils.

Dated this 26th day of August 1905.

HERBERT HADDAN & Co.,
Agents for Applicant.
31 & 32 Bedford Street, Strand, W.C. London.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1906.

[This Drawing is a reproduction of the Original on a reduced scale]

Fig. 1.

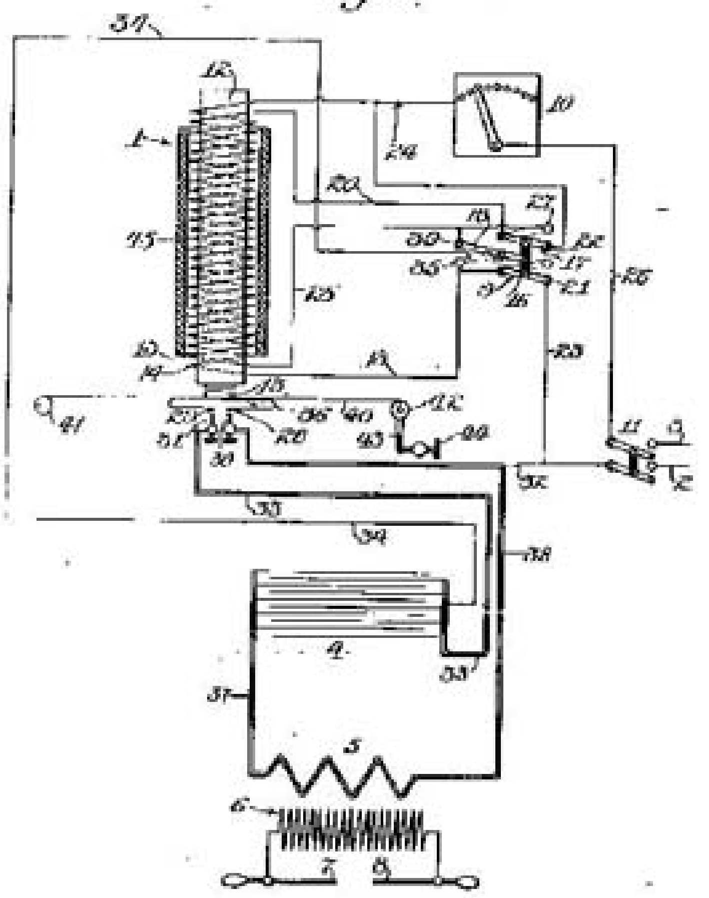


Fig. 2.

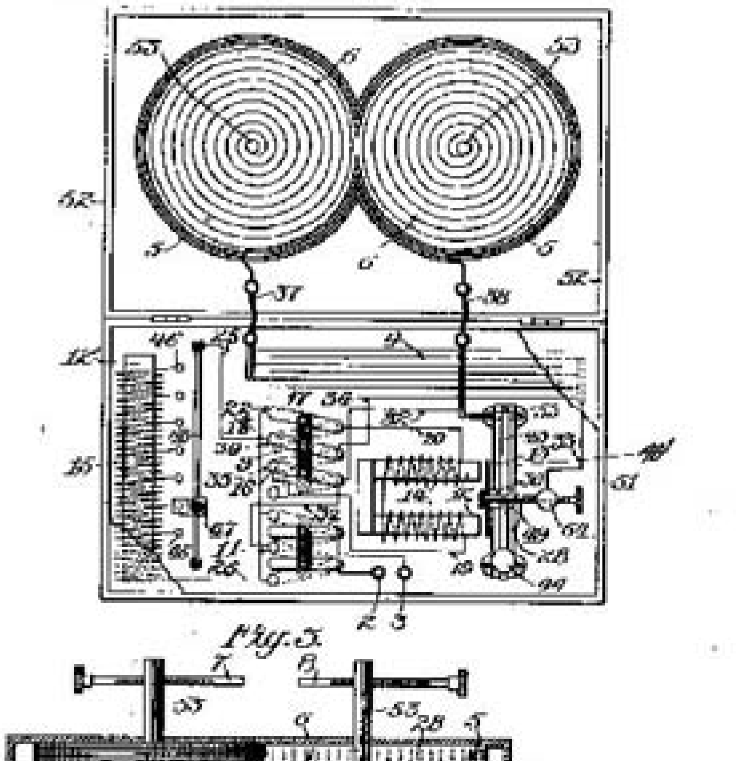


Fig. 3.

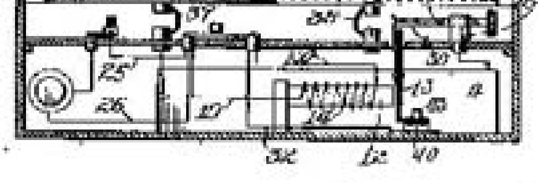
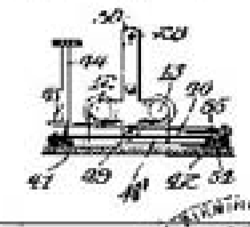


Fig. 4.



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A.D. 1905. Aug. 26. N.º 17,308.

HADDAN'S COMPLETE SPECIFICATION.

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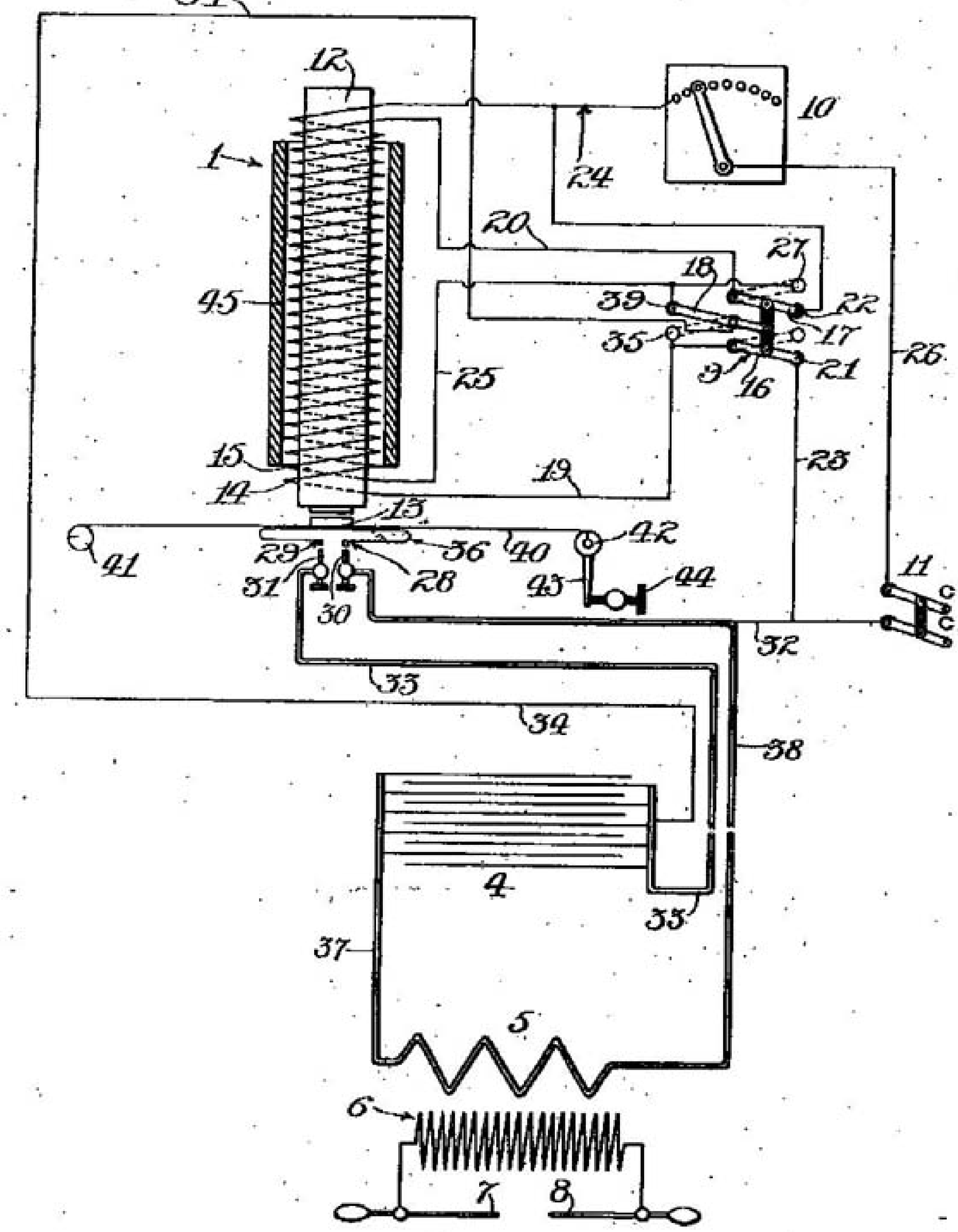
Fig. 1.



SHEET 1.

(2 SHEETS)
SHEET 2.

Fig. 2.

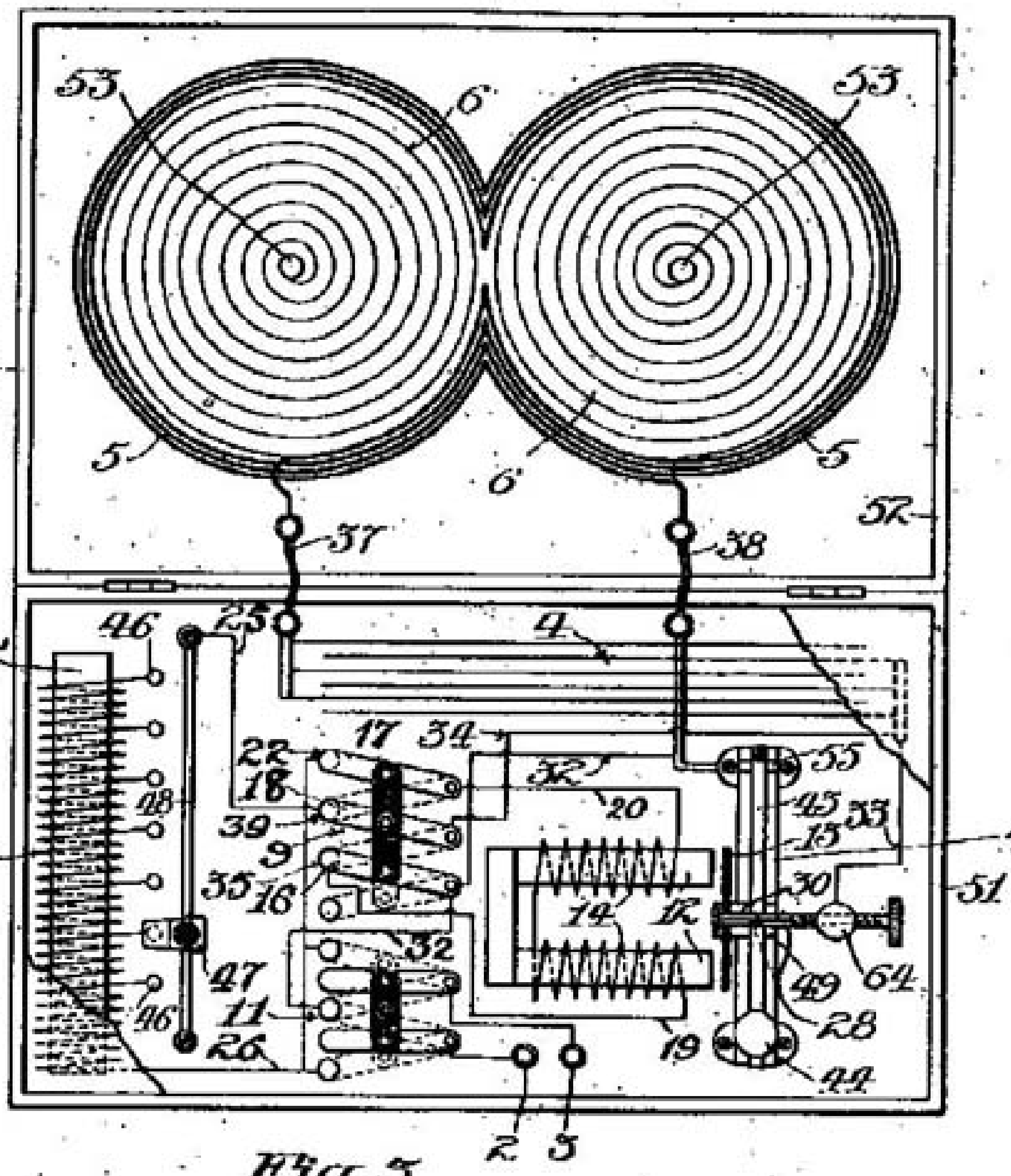


Fig. 3.

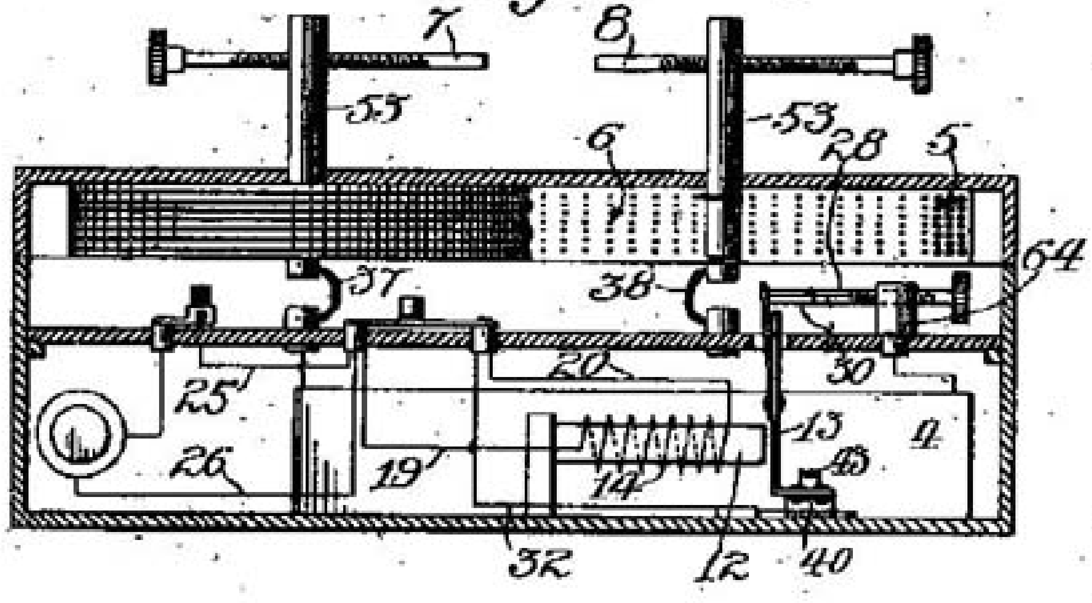
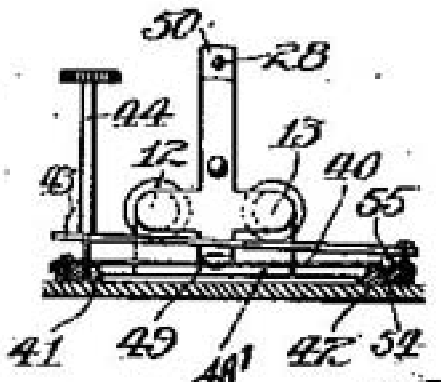


Fig. 4.



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N° 24,143 A.D. 1910

Date of Application, 18th Oct., 1910—Accepted, 18th Oct., 1911

COMPLETE SPECIFICATION.

Improvements in High Frequency Electric Apparatus.

I, MONICO SANCHEZ, of 63 Thirteenth Avenue, in the City of Newark, County of Essex, and State of New Jersey, in the United States of America, Engineer, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

My invention relates broadly to improvements in electrical apparatus having an oscillating circuit of capacity and inductance in series, the proportions being such that a high frequency of oscillation is produced therein. Specifically, my invention is adapted to be used in generating high frequency currents of either high or low potential.

The embodiment which I have chosen for purposes of illustration in this specification, but to which I do not wish to be limited, as my invention is of broad application, comprises in small compass, readily portable means for generating high frequency, high potential currents from either an alternating or a direct current supply. The current thus produced may be used with high frequency electrodes, with X-ray or wireless telegraph apparatus, or with any of the many other familiar applications of high frequency current. In addition are included in my instrument, means for producing high frequency, low potential, current for use with the electric cautery or similar purpose, where high calorific effect rather than high voltage is requisite.

My apparatus is comparatively inexpensive, is portable, may be connected to any commercial lighting circuit, whether direct or alternating, and may, because of its simplicity, be efficiently handled by even an unskilled operator. The results accomplished are on a par with those hitherto obtainable only with high frequency apparatus of much greater weight, cost, and complexity than my apparatus. In some respects I regard the currents produced by my instrument to be superior to those obtainable with prior instruments, and notably so with reference to electro-therapeutic, X-ray, and electro-cauterizing work.

The general type of apparatus to which my invention relates is familiar and comprises in its circuit capacity and inductance in series with an interrupter, a potential transformer, and a supply circuit for impressing voltage across the portion of the circuit including the capacity.

According to said invention, the current is applied to the capacity and the interrupter independently of the primary of the transformer. In my improved apparatus the charging circuit, including the capacity or condenser and the coil of the interrupter, is separate and distinct from the oscillatory or discharge circuit which includes the primary of the transformer, the capacity or condenser, and the contacts of the interrupter; and the oscillatory or discharge circuit is what I will herein term balanced, that is to say, the relative values of the inductance and capacity entering into this circuit when in a state of discharge are adjusted in substantially the ratio hereinafter indicated so as to obtain the highly oscillatory effect produced by this apparatus.

In the accompanying drawings:—

Fig. 1 is a circuit diagram showing the internal connections of my apparatus; Fig. 2 is a modification of the circuit diagram shown in Fig. 1; Fig. 3 is a plan view of my improved apparatus; Fig. 4 is a front elevation thereof, parts being broken away; Fig. 5 is a detail elevation partly in section of my improved

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potential transformer; Fig. 6 is a plan view thereof; and Fig. 7 is a fragmentary sectional view showing in detail the means for separably connecting in place the adjustable electrode of the spark gap.

Referring in detail to the drawings: the numerals 1 and 2 designate wires entering the apparatus from an external supply circuit, which may furnish either direct or alternating current. Wire 1 leads to the energizing coil 3 of the electro-magnetic interrupter having the core 4 of soft iron, or other suitable material, adapted to attract the armature 5 which has a contact 6, attached by the spring 7 to the stationary block 8. Contact 6 is adapted normally to bear against contact 9 of the block 10, which is adjustable in the direction of vibration of the block 5. A wire 11 leads from the coil 3 of the electromagnetic interrupter to the inductance coil 12 whose core 13 is composed of a suitable substance having high magnetic permeability. The other end of the coil 12 is connected by the wire 14 to the block 8 above described. Shunted across the coil 12 is a line including wire 15, switch 16 and wire 17. From the block 8 wire 18 leads to condenser 19, the other side of which is connected to the wire 20, which branches at the point 21. Leading from this point are the wires 22 and 23, the latter forming one side of the cautery circuit hereinafter to be described in detail. The wire 22 leads to the point 24 where it is joined to the wire 2 of the supply circuit, and the wire 25 leading to the low potential coil 26 of my potential transformer, from the other end of which wire 27 leads to the point 28, where the wire branches, one branch 29 leading through the switch 30 to the branching point 31, there dividing into wire 32 forming the second side of the cautery circuit hereinbefore mentioned, and wire 33 which continues to the adjustable block 10 of the magnetic interrupter. From the point 28 wire 34 leads to the high potential winding 35 of my potential transformer. From this same point terminal wire 36 extends, the other end of the high potential winding being connected to the other terminal wire 37.

Referring now to Figs. 3 and 4, my apparatus will be seen to consist of a casing 38 adapted to contain within small compass the complete apparatus, with the exception of the adjustable electrode. Within this casing are included the elements above described in the circuit diagram, the electrodes, adjustable spark gap and interrupter being shown in detail. The interrupter comprises coil 3, flat spring 39, armature 5, carrying the contact 6 borne on the end of the flat spring 7 rigidly attached to the block 8. The element 39 is an important feature of my apparatus, but is herein claimed as new only in conjunction with the apparatus embodying my present invention, that is to say, one in which the current is applied to the capacity and the interrupter independently of the primary of the transformer. It is preferably constructed of spring brass, or some other resilient non-magnetic material. Its function is two-fold: it effectually prevents the armature from sticking to the core of the magnet through the action of residual magnetism, and at the same time sharpens the action of the interrupter in forcing the armature to return more quickly to the stationary contact after breaking the circuit. Contact 9, which, as well as contact 6, is preferably made from a metal having a very high melting point, is adjustable through the action of the screw 40, which carries on its other end operating wheel 41 and which works in the internally threaded block 42. Switch 16 I preferably form as a link 43 pivoted to the standard 44, its slotted end 45 adapted to be clamped beneath the nut 46. In similar manner I form switch 30 of the link 47, whose slotted end 48 may be clamped under the nut 49, while its pivoted end is attached to the standard 50. Sockets 51 and 52 are attached, respectively, to the ends of the wires 1 and 2, and in them may be placed means for conducting current from the supply mains. I provide switch 90 having the operative point 91 and dead point 92 for interrupting the main supply circuit.

Connected to the end of the wire 37 leading from the high potential winding of the potential transformer is the metal shaft 53 carrying at its upper extremity the spherical discharge electrode 54 which may be provided with a pointed tip 55. Connected to the wire 36 leading from the other end of the high potential winding, I provide the adjustable spark gap apparatus consisting of the bent wire 56 having a horizontal portion 57 which may be rotated in a horizontal direction, as indicated by the dotted line 58, whereby the distance between the pointed extremity 59 of the wire and the spherical electrode 54 may be adjusted at will, the wire 56 being pivoted in the socket 60 and the lower end being provided with the insulating handle 61.

The interrupter and switches above described I preferably mount upon a slab 62 of material having a high dielectric strength and at the same time unaffected by considerable changes in temperature. For this purpose I find slate to be an excellent material. Adjacent to this I provide the plate 63 which must also be of high dielectric strength, but is not subject to any violent temperature fluctuations, and which therefore I preferably construct of hard rubber. Within the casing and mounted preferably below the interrupter and separated from it by the slate slab, I mount the inductance coil 12. Adjacent to it is placed the condenser 19 and next to it the high potential transformer which is shown in detail in Figs. 5 and 6.

This high potential transformer is constructed as follows:

Upon an ebonite, fibre or rubber ring 64 is placed a strip of non-conducting material, such as paper, over which are wound a number of turns 35 of fine insulated wire, side by side, and as close together as possible. Over the coil thus formed is wound another layer of paper 95 and upon this in turn wound another layer of wire. This process is repeated until a coil having the requisite number of turns of the high potential winding is built up. Wound about this high potential winding are a small number of turns of heavy insulated conductor 26, so disposed that they shall be directly over the high tension winding.

The potential transformer I construct as above described in order to obtain maximum efficiency and transformer effect in as small a compass as possible. Winding the high potential coil in a substantially flat coil instead of in a helix concentrates the flux and makes it possible to obtain high efficiency with only a very small number of turns of the primary, say two or three, for a large number of turns of the secondary, or high potential side. When the transformer is assembled, as described, the whole is placed in a casing or box 93, then placed in a vacuum and hot molten insulating compound, such as wax, poured into the box, so that it surrounds the windings on all sides, impregnates the paper tape and the insulation of the wire, and when cool forms the unitary block 94 within the casing 93. Within the ring 64 is a block 65 of conducting material such, for instance, as brass, having a socket 66 adapted to receive a plug 67 mounted on the lower end of the shaft 53. Socket 68 of insulating material is provided for the reception of the lower end of the shaft 53. To the block 65 is electrically connected the inner end of the high potential winding, the outer end of which, as is shown in the circuit diagram, is connected to one end of the low potential winding.

In Fig. 7 I have illustrated in detail the construction of the detachable means for securing the adjustable portion of the spark gap in place at the side of the casing. For this purpose I provide a socket 69 of conducting material, such as brass, which is set into the side of the casing and contains the opening 70 for the reception of the plug 71 entering the insulating handle 60. Through this handle passes conductor 72 which is in electrical contact with and pivoted to the lower end of the bent wire 56.

In Fig. 2 I have illustrated a modification in which I employ two potential transformers instead of one. In other respects the wiring is the same as that illustrated in Fig. 1. From the point 24 leads the wire 73 to the low potential winding 74 of one of these transformers, the other side of which is connected by the wire 75 to the high potential winding 76 at the point 77. The other end of the high potential winding is connected to the discharge wire 78. From the point 77 a second wire 79 continues to the point 80 at one end of the high potential winding of the second transformer, the other end of which is connected to the discharge wire 81. From the point 80 a second wire 82 leads to one end of the low potential winding 83 of the second transformer, to the other end of which is connected the two-point switch 84. Wire 85 joins the other side of switch 84 to switch 30. The second contact point 86 of switch 84 is connected to wire 87 which is a branch leading from wire 82.

In the operation of my device, wires leading from the supply circuit having been attached to sockets 51 and 52, and the switch 90 having been thrown to the operative point 91, the wheel 41 of the interrupter is rotated until contact 9 touches contact 6. Assuming the condition to be that switch 16 is closed, which is the correct condition when an alternating current supply is used, current will now flow from the supply through wire 1, coil 3, wire 11, wire 15, switch 16, wire 17, block 8, spring 7, block 5, contact 6, contact 9, block 10, wire 33, switch 30, wire 29, wire 27, winding 26, wire 25 and wire 2, thus energizing coil 3, the core 4 of which will attract its armature 5, drawing apart contacts 6 and 9. Current will then flow into and charge the condenser through the wires 18 and 20, in shunt across the interrupter contacts. When contact 6 breaks with contact 9, the current in the circuit will persist and voltage will suddenly be built up through the action of the winding of coil 3. This building up of the voltage suddenly will charge the condenser 19 to a much greater extent than if simply the supply voltage were impressed across it. Immediately upon the armature 5 being attracted sufficiently to break the circuit of which contacts 6 and 9 are a part, the core 4 will cease to be energized and the spring 7 will cause armature 5 to fly back and contact 6 will again touch contact 9. When this occurs there will be a discharge of the condenser 19 through the oscillatory circuit comprising the condenser, wire 20, wire 22, wire 25, low potential winding 26, wire 27, wire 29, switch 30, wire 33, block 10, contacts 9 and 6, armature 5, spring 7, block 8 and wire 18. When the apparatus is working at high speeds, it is probable that the discharge takes place even before the contacts touch. When the contacts separate, a spark is formed, due to the inductance in the supply circuit, and the condenser may then discharge during the life of this spark, which in forming has broken down the high electrical resistance across the gap. Now, since the low potential winding is designed to be of low electrical resistance, the discharge of the condenser will be highly oscillatory in character. The oscillatory high frequency current thus set up in the circuit just described will be changed through the interaction of the high potential winding 35 and the low potential winding 26 into an oscillatory high frequency, high potential current, the frequency as well as the electrical pressure being materially increased.

In the instrument of the electrical dimensions described in this specification, I find that the frequency of the current drawn from the discharge terminals is between 7,000,000 and 7,500,000 per second, while the frequency of the oscillations in the oscillatory circuit comprising the capacity and low tension side of the potential transformer is in the neighbourhood of 100,000. The frequency of the cautery circuit likewise approximates to this figure. The alternate charge and discharge of the condenser will be repeated at frequent intervals through the action of the magnetic interrupter, as just described, and the high frequency, high potential oscillatory current will be continuously produced between the discharge wires 36 and 37. The strength of this current will be dependent upon the degree to which the wheel 41 is rotated. The longer the play of the spring 7 and the armature 5, the slower will be the rate at which the condenser will charge and discharge. The forcing of the contact 9 nearer the contact 6 will shorten the period of oscillation of the spring, and therefore will increase at will the rate of charge and discharge of the condenser and consequently the power which is expended in the oscillatory circuit and which is available in the form of high frequency, high potential oscillatory current at the discharge terminals. Since, however, the oscillatory character of the current in the oscillatory circuit including the capacity and the low potential winding is dependent solely upon the electrical constants of this circuit, the frequency of the current available at the discharge electrodes will be independent of the position of the contacts of the interrupter.

When the instrument is used from a direct current supply the switch 16 is opened, thereby including in the main circuit the impedance coil 12 having a core 13. The object of this coil is two-fold; first, its reactance tends to prevent the surging back of the oscillatory discharge from the condenser into the supply circuit; and second, its resistance and reactance together cut down the amount of current flowing through the main circuit from the supply. When alternating current is used, this coil is not needed for the reason that the reactance of the coil 3 of the interrupter is sufficient to cut down the current flowing in this case, and also to overcome any tendency of the oscillatory discharge to surge back into the main supply circuit.

In the practical construction of my apparatus I find that the electrical constants suitable for the production of an instrument for use upon commercial electric circuits of approximately 110 volts, are as follows: The ratio of the electrical resistances of the low potential to the high potential windings, respectively, I make about 0.001 to 100, the high potential coil having a resistance of about 75 ohms, and the resistance of the low potential coil being almost negligible; the ratio of the number of turns of the low potential winding to the high potential winding should be approximately 1 to 600, two or three turns of the low potential winding to 1750 turns of the high potential winding being what I find desirable in practice; the capacity of the condenser used is about 0.4 of a microfarad. These figures as to the specific quantities used apply to an instrument having a single potential transformer. The proportions hold good for larger instruments having a double transformer, but in this case the capacity of the condenser must be correspondingly increased, and I find that a capacity of approximately 0.75 of a microfarad is correct for use in a double transformer instrument wherein the other quantities remain the same as have been described for the single transformer apparatus. The preferred dimensions of the potential and oscillation transformer are as follows:—

Over all diameter of the secondary $4^1/_4$ inches; average number of conductors per layer of secondary, 34; internal diameter of coil, $1^1/_8$ inches. It will be understood that the primary consists of two, or preferably three, turns of larger wire wound about the secondary, as indicated in the drawings. The total number of turns has already been given above; and from these figures it is easy to obtain the approximate inductance.

In the use of my apparatus with vacuum electrodes, I prefer to connect the electrodes by any suitable electrical conductor to the spherical electrode 54. By altering the length of the spark gap between the points 59 and 55, the amount of current made to discharge through the vacuum electrode may be altered at will to a nicety. My instrument is especially adapted for use with X-ray apparatus because of the peculiar character of the current produced. Owing to its highly oscillatory nature, the tube may simply be connected to the spherical electrode 54 by any suitable conductor, a closed electrical circuit back through the other electrode not being necessary. It is a matter of common knowledge to those skilled in the art that the use of an X-ray tube for considerable periods at a time heats the tube to such an extent that after long use the temperature may rise sufficiently to break the vacuum through the unequal expansion of the glass and electrode where the latter pierces the tube. When my apparatus is attached to an X-ray tube in the manner I have described, by a single wire, I find there is practically no serious heating effect produced, while the rays generated are fully as powerful as those which are achieved in the old manner of forming a closed electric circuit through the X-ray tube, an induction coil being used to energize the tube.

The operation of the instrument diagrammatically illustrated in Fig. 2 is similar to that of the instrument already described. Two potential transformers are provided, however, and much more powerful effects are therefore obtainable. Caution must be observed in connecting these transformers in the circuit when two are used, as it is necessary in order to produce the most useful results, that the voltages available at the two terminals shall be opposed in phase. If the voltage at one terminal reached a maximum when the pressure at the other also was greatest, the potential difference across them would be practically zero. The two-point switch 84 is provided in order to enable the cutting out of one of the transformers when the full strength of the instrument is not required.

A novel and highly valuable feature of my invention is embodied in the cautery or heating circuit which operates as follows: Considering the switch 30 to be opened and voltage impressed across the supply terminals, current will flow through wire 1, coil 3 of the interrupter, wire 11, wire 15, switch 16, wire 17, block 8, spring 7, armature 5, contact 6, contact 9, block 10, wire 33, wire 32, wire 23, wire 22 and wire 2, provided that an electric cautery or other electrical conductor is connected across the wires 32 and 23. The first rush of current will energize the coil 3 and core 4 of the interrupter, attracting armature 5 and breaking the circuit between the contacts 6 and 9. When these contacts break, owing to the inductance of coil 3, current will tend to continue to flow and voltage will be built up, charging the condenser, through wires 18 and 20, to a much greater extent than it was by the supply voltage at first. The breaking of the contacts 6 and 9 will, however, immediately de-energize the core 4 of the interrupter, contact 6 will fly back through the action of the spring 7 and again touch contact 9. When this occurs the condenser will discharge through the discharge circuit including wire 20, wire 23, cautery or other electrical conductor connected in the external circuit, wire 32, wire 33, block 10, contact 9, contact 6, armature 5, spring 7, block 8 and wire 18 to condenser 19. If there is sufficient inductance in the supply circuit, a spark may be formed when the contact points separate, thus breaking down the electrical resistance across the gap, and in this event the condenser will discharge before the contacts again touch. Since the rate at which the condenser alternately charges and discharges depends upon the force with which the contact 6 initially presses against contact 9, and owing to the fact that contact 9 is adjustable with reference to contact 6, the rate of vibration of the armature 5 and the consequent rate at which the condenser will be charged and discharged, may be varied within wide limits, and the amount of energy expended in heat in the external cautery circuit between wires 32 and 23 may be regulated accurately within corresponding limits.

This construction and wiring is especially well adapted for use with the electric cautery, inasmuch as the temperature of the cautery can thus be regulated from atmospheric to incandescence by the simple turning of the adjusting wheel of the interrupter. The use of my apparatus with the cautery in this manner requires the expenditure in the supply circuit at ordinary commercial voltages of only a fraction of an ampere in order to heat even the heaviest of electric cauteries usually employed in medical work. Electric cauteries hitherto used have required a large expenditure of power and an amperage such that the apparatus could not be attached directly to the ordinary lighting circuit, in addition to requiring bulky rheostats for governing the current flowing through and therefore the temperature of the cautery. Since my apparatus when used for this purpose requires only a small amperage it may be attached direct to any lighting circuit without danger of blowing a fuse through drawing too much current.

When using a direct current supply with the cautery, switch 16 is opened for a similar purpose to that described above in connection with the utilization of the apparatus for high frequency work.

Having now particularly described and ascertained the nature of my said invention, and in what manner the same is to be performed, I declare that what I claim is:—

1. In high frequency electric apparatus, a circuit comprising capacity and inductance in series with an interrupter, a potential transformer, and a supply circuit for impressing voltage across the portion of the circuit including the capacity, in which the current is applied to the capacity and the interrupter independently of the primary of the transformer.

2. High frequency electric apparatus of the kind referred to in Claim 1, having a charging circuit including the capacity or condenser and the coil of the interrupter, and having also a separate or distinct oscillatory or discharge circuit including the primary of the aforesaid transformer, the capacity or condenser, and the contacts of the interrupter.

3. High frequency electric apparatus of the kind referred to in Claim 1, in which the oscillatory circuit is balanced by the adjustment of the relative values of the capacity and inductance, for the purpose set forth.

4. High frequency electric apparatus of the kind referred to in Claim 1, having means for short-circuiting the aforesaid inductance.

5. In or for high frequency electric apparatus of the kind referred to in Claim 1, a potential transformer, in which the ratio of the number of turns of the low pressure winding to the high pressure winding is between 1 to 580 and 1 to 900.

6. High frequency apparatus as set forth in Claim 5, in which the ratio of the electrical resistance of the low potential and the high potential windings is about 0.001 to 100, the high potential winding having a resistance of about 75 ohms; and in which the condenser has a capacity of about 0.4 microfarad.

7. In combination with high frequency electric apparatus of the kind referred to in Claim 1, means for producing high frequency, high voltage electric current, and means for producing high frequency, low voltage current, and means for varying the amperage of each.

8. In high frequency electric apparatus of the kind referred to in Claim 1, an electro-magnetic current interrupter having resilient means for preventing the armature from sticking to its core, such as a resilient buffer between said magnet and said armature.

9. In or for high frequency electric apparatus of the kind referred to in Claim 1, a plurality of combined potential and frequency transformers connected or adapted to be connected in such manner as to have their primaries in the circuit of the capacity and interrupter and to have the potentials between their secondary terminals substantially 180 degrees apart in phase.

10. In high frequency electric apparatus having a device of the kind referred to in Claim 9, means for cutting out of the circuit all but one of the primaries of said transformers.

11. High frequency apparatus as set forth in Claim 1, having a cautery circuit substantially as described from which the transformer can be cut out by a switch such as 20, the discharge circuit then including the condenser, the contacts of the interrupter, and the cautery.

Dated this 18th day of October, 1910.

PHILIP M. JUSTICE,
Chartered Patent Agent,
London,
For the Applicant.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1911.

A.D. 1910. Oct. 18. N° 24,143.
SANCHEZ'S COMPLETE SPECIFICATION.

(2 SHEETS)

SHEET 1.

[This Drawing is a reproduction of the Original on a reduced scale]

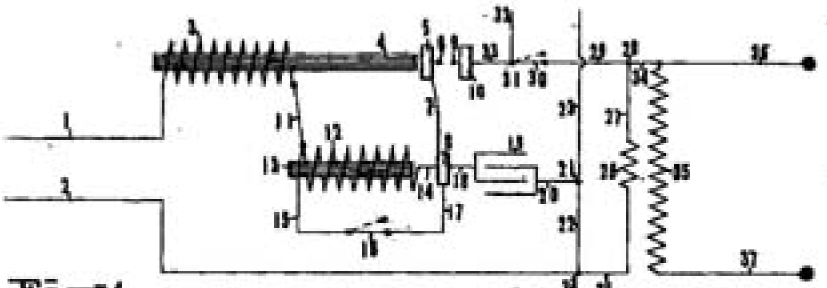

Fig.1.

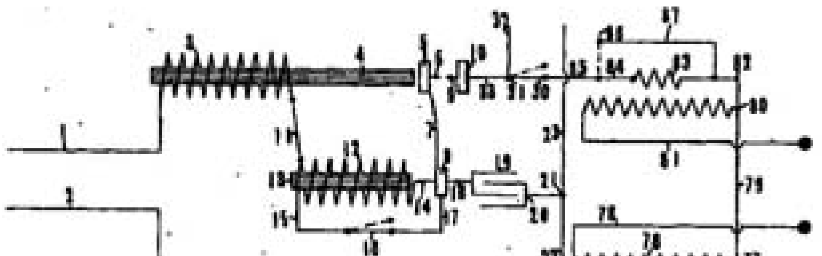

Fig.2.

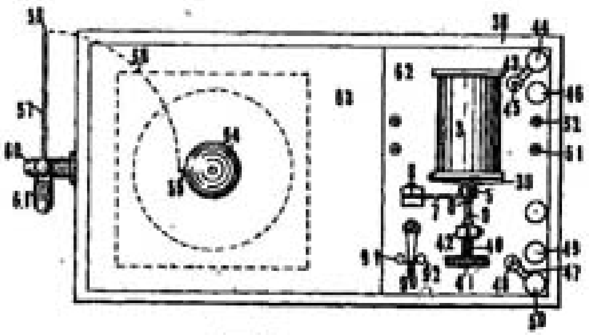

Fig.3.

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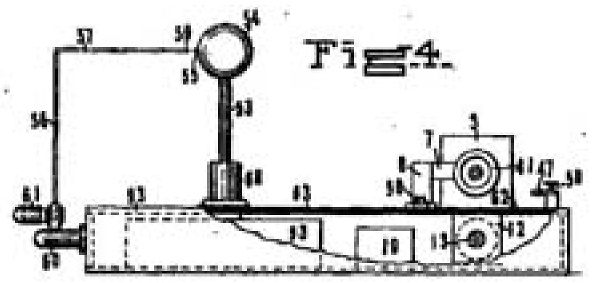

Fig.4.

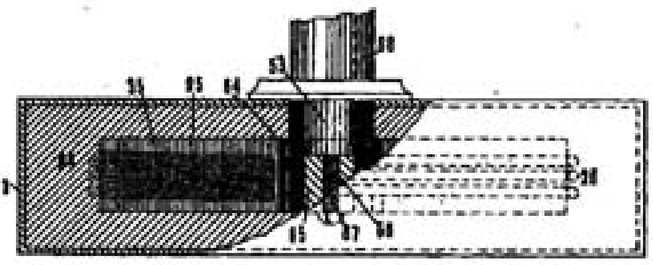

Fig.5.

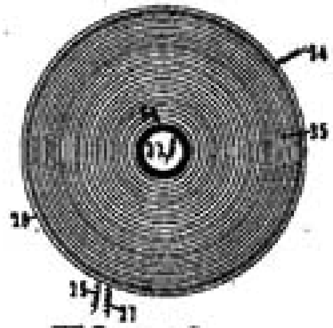

Fig.6.

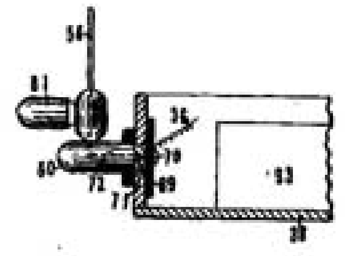

Fig.7.

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A.D. 1910. Oct. 18. No. 24,143.
SANCHEZ'S COMPLETE SPECIFICATION.

SHEET 1.

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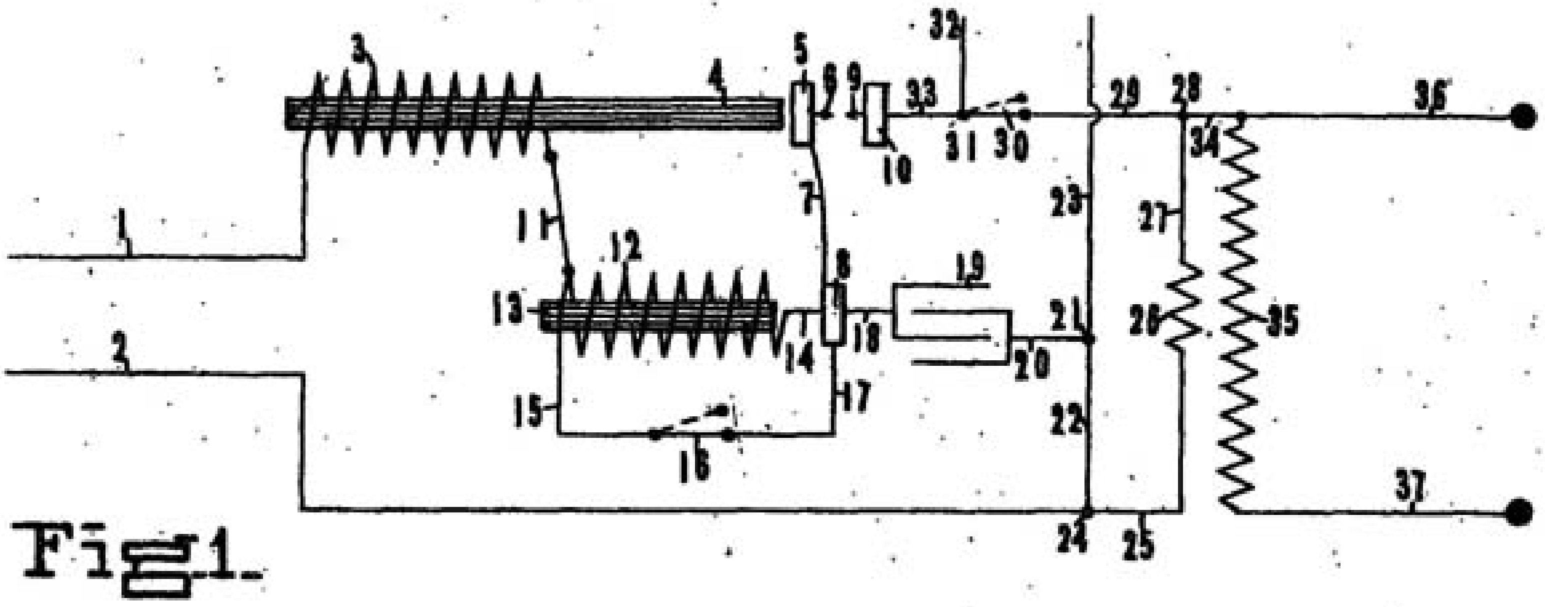

Fig1.

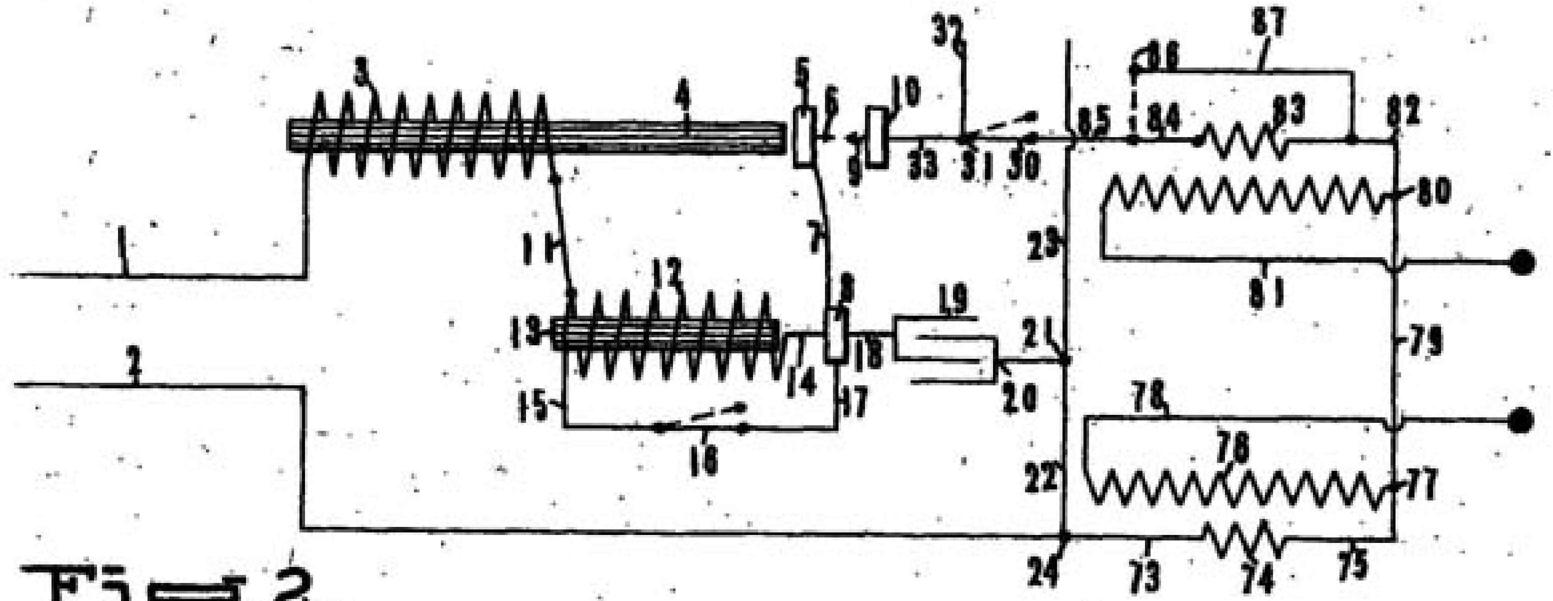

Fig.2.

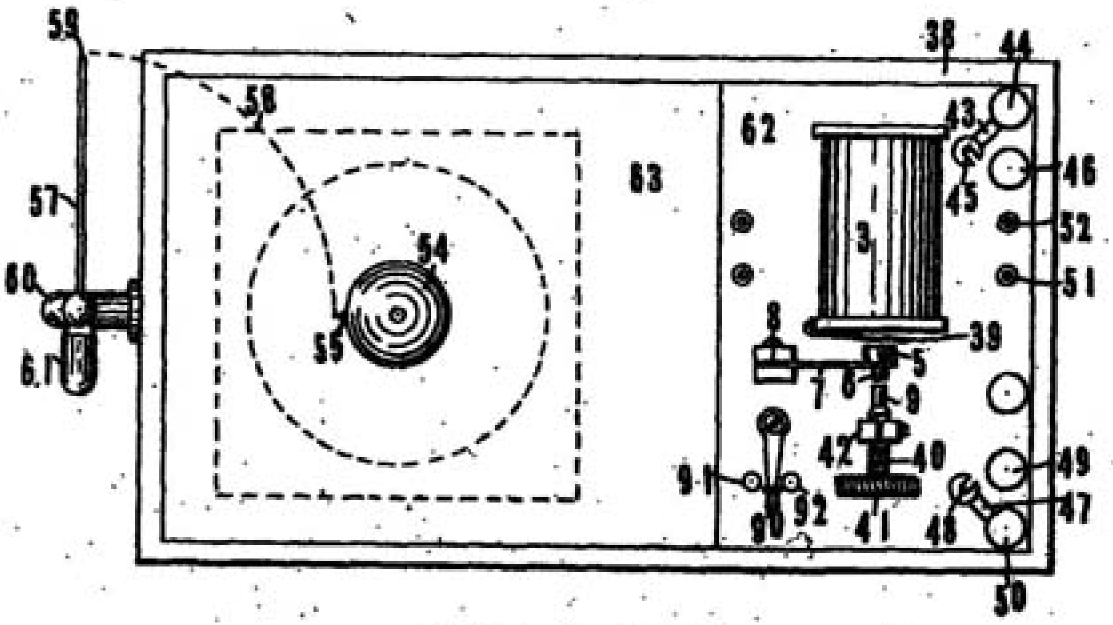

Fig.3.

Nº 17,308 **A.D. 1905**

Date of Application, 26th Aug., 1905—Accepted, 2nd Aug., 1906

COMPLETE SPECIFICATION.

"A New or Improved Apparatus for Producing Electrical Discharges."

I, HERBERT JOHN HADDAN, of the Firm of Herbert Haddan & Co., of 31 & 32 Bedford Street, Strand, W.C. London, Consulting Engineer, do hereby declare the nature of this invention, a communication to me from abroad by The Synchronous Static Company, a corporation organized under the laws of the State of California, and having its principal place of business at 223—224 Douglas Building, Los Angeles, California, United States of America, and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to an apparatus for producing electrical discharges of high frequency and intensity. Such discharges are used for the production of X-ray effects, and in various therapeutical and other applications, and my invention is applicable to any of such uses.

An important object of the invention is to provide an apparatus for this purpose which will be adapted for operation by either alternating or direct current so that it can be applied in connection with any of the usual distributing circuits now in use.

Another object of the invention is to provide for a maximum energy of discharge for a given amount of energy supplied.

A further object of the invention is to increase the rapidity of oscillation of the discharge.

Another object of the invention is to provide for adapting the apparatus for operation with alternating supply circuits of different periodicity.

In the accompanying drawings, Figure 1 is a somewhat diagramatic illustration of one form of the invention.

Fig. 2 shows a more complete form of the invention.

Fig. 3 is a vertical section of the form shown in Fig. 2.

Fig. 4 is an end elevation of the interrupter.

Referring to Fig. 1, the apparatus comprises an electro-magnetic device 1 adapted to receive electric energy from the line terminals or supply wires 2, 3, and to produce from the direct current or alternating current supplied thereby, discontinuous impulses of higher potential; a condenser 4 connected to receive such impulses from the electro-magnetic device; an induction device having its primary coil 5 connected to receive the discharge from the condenser and its secondary coil 6 connected to discharge terminals 7, 8, and adapted to produce at such terminals a discharge whose frequency and potential are sufficiently high to give the desired effects; a switch 9 for changing the supply connection of the electro-magnetic charging device 1 to adapt the apparatus to direct current or alternating current; a rheostat or equivalent device 10, for regulating the operation of the apparatus, or for adapting it to differences in potential of the supply circuit; and a switch 11 for making or controlling the connection between the apparatus above specified and the supply circuit 2, 3.

The electro-magnetic device 1 comprises a core or body 12 which may be made of soft iron wire with suitable windings thereon, and an armature 13 supported in proximity to the end of the core by suitable elastic retracting

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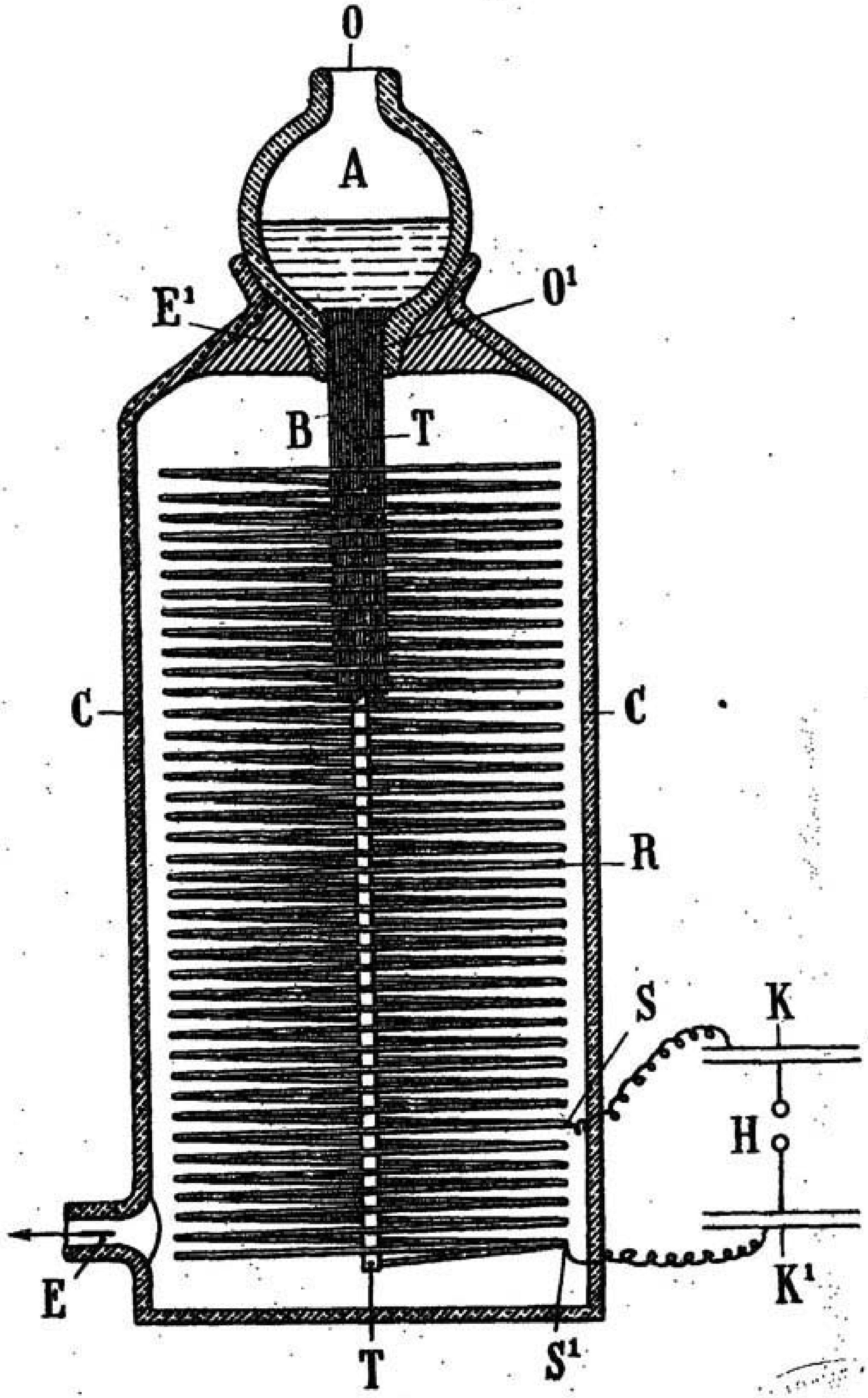
(2 SHEETS)
SHEET 2.

Fig. 2.



Malby&Sons, Photo-Litho.

any other porous substance forming a wick B which allows the liquid air to flow in quantity proportional to requirements, the rate of flow being adjustable by stuffing the substance of this wick in the orifice more or less tightly. The relative reduced area of the orifice O may also aid this flow by the excess of pressure on the liquid.

The liquid air will thus descend by capillary action to about midway within the resonator around the central bar T and the discharge will be compelled to traverse the liquid air at the very moment of its expansion.

The space E^1 may be filled up as much as may be desired by di-electric material in order to protect the liquid air receptacle against the direct discharge.

R the resonator is connected in the usual manner to the condensers K and K^1 by the contacts S and S^1, S^1 being the lower spiral of the resonator. This spiral S^1 is also connected to the metal rod T which rises along the axis of the resonator and up the centre of the asbestos wick B to the highest level at which the liquid air expands and becomes gasified.

The discharge takes place between R and the upper end of the rod T and is thus compelled to traverse the layer of air which is still liquid at the very moment of its expansion.

This apparatus presents the following advantages;—

1. Considerable difference in temperature between B and R; an excellent condition for the intense production of ozone.

2. Expansion of the liquid air in the very centre of the discharge and, very probably, owing to the air being then in a transitory state, an easier liberation of the ion O, and of the molecule O_3.

3. Production, by reason of the rod T, of a discharge of very considerable power in relation to the quantity of electricity in use.

4. Action of the discharge upon air very rich in oxygen, as the previous manipulations and transfusions will have already caused the liquid air to lose the greater part of its nitrogen.

The general process described above, consisting in effecting the expansion of the liquid air in the centre of a discharge may be realised by means of several arrangements similar to that which has just been described.

Liquid air can be sent into the centre of the apparatus by any suitable mechanical process other than that described above, and in such case the discharge will be produced in a medium having a temperature that is as low as or is but little higher than—180° C.

If such a low refrigeration be considered useless, and yet it be desired to start with liquid air so as to benefit by its richness in oxygen, this can be done very simply, by placing the liquid air receptacle in the lower part of the apparatus and causing it to rise at the moment of its gasification in the central hollow rod which will form a continuation of the neck of the receptacle; in this case the vacuum between the double wall of the receptacle may be made in such a way as to regulate the output in an invariable manner and to render it more rapid than with the actual Crookes vacuum.

If it be not desired to benefit by the relative richness of liquefied air in oxygen, the operations of liquefaction may not be carried so far and only highly cooled air be sent into the ozonizer by a Linde or Claude engine, and that always preferably through a central rod located at the axis of the resonator.

There will always however be an advantage in cooling the air to be ozonised as much as possible, the output of the apparatus being all the higher the lower its mean temperature.

If however it be desired not to complicate the apparatus by a liquid air apparatus, the air to be ozonised can be cooled, but much less effectively, by means of a coil located in the central rod and traversed by a current of liquid carbonic dioxide, or liquid sulphurous acid gas (SO_2) at the moment when they again pass from the liquid to the gaseous state, or even of ammonia as in the ordinary ice machines.

In other arrangements of the apparatus of the type above described two resonators may be arranged and such an arrangement will also give excellent results; the combination of two resonators increases the length of the space traversed by the discharge which then occupies the whole height of the resonator carrying the central rod.

Figs. 3 to 7 represent, by way of example, various modifications each having two resonators.

In Fig. 3 the upper spiral of one resonator *r* is connected to the upper spiral of the second resonator r^1 and the rod T is connected to the lowest spiral *a* of the resonator *r*.

In Fig. 4 the upper spiral of *r* is connected to T, the lower spiral *a* to the lower spiral of r^1; this arrangement is particularly advantageous.

Fig. 5 shows an arrangement similar to that in Fig. 1, but the rod T is replaced by a second resonator r^1 of less diameter than the first one *r* and concentric thereto.

In Fig. 6 two concentric resonators are connected as shown in the diagram to two different sources X and Y of high frequency current.

In Fig. 7 the two concentric resonators *r* and r^1 are arranged in the manner indicated in the figure, the arrangement may however, be modified in many ways as regards the position of the condensers X, Y. This arrangement is somewhat similar to the preceding one wherein the two sources of energy are combined to form one only, so to speak.

As in the case of the apparatus described with reference to Fig. 2 all the arrangements which have been mentioned are contained in a closed space having inlet orifices for the air and outlets for the ozonised air.

The liquid or compressed air is conveyed thereto by anyone of the means hereinbefore mentioned, so as to be submitted to the action of the discharge.

In the modifications shown in Figs. 5, 6 and 7 the inner resonator r^1 can be formed by a coil serving as a carbon-dioxide, sulphurous acid (SO_2) or ammonia refrigerator, as has been stated in connection with the apparatus shown in Fig. 1.

A certain number of the apparatus above described may be grouped together to form a battery.

Dated this 23rd day of December 1904.

For the Applicant,
F. WISE HOWORTH, F.C.S.,
46 Lincoln's Inn Fields, London, W.C.
Chartered Patent Agent.

COMPLETE SPECIFICATION.

Improvements in Apparatus for the Production of Ozone.

I, Paul Marie Oudin, of 12 rue de Belzunce, Paris, Doctor of Medicine, do hereby declare the nature of this invention and in what manner the same is to be performed to be particularly described and ascertained in and by the following statement:—

This invention relates to apparatus for the ozonisation of liquid or gaseous air by subjecting it to a very powerful electrical discharge obtained by the use of apparatus known as the Oudin resonator.

In the industrial application of this apparatus a serious inconvenience occurs owing to the tendency which the electrical influence has to escape from the resonator thus leaving the whole of the central space useless and consequently injurious in consequence of the large quantities of air or oxygen which pass through it without being converted into ozone; on the other hand if the coils of the resonator are wound round a cylinder of wood or other insulating substance, the armature thus formed speedily gets hot and so considerably reduces the output, which, as is well known, is nearly inversely proportional to the temperature of the ozoniser.

Moreover, an Oudin resonator when constructed in the usual way only emits electrical influences at the level of its two or three upper coils. The available zone is therefore small compared with the total volume of the apparatus.

These inconveniences are obviated by arranging the resonator as shown in the diagram marked Fig. 1 of the drawing accompanying my Provisional Specification.

In this drawing R is a resonator connected in the usual way at *a* and *b* to a generator of high frequency currents, which may be produced for example by a magneto-electric machine or a Rhumkorff coil, or an alternator and any industrial transformer. If at the axis of this resonator there is located a metallic conductor T connected to the lower coil of the resonator or to the source of supply of the current to this coil, it will be seen that the electrical influence instead of flowing outward to the resonator, will flash between the coils and the central conductor, and by suitably adjusting the resonator, an extremely copious and brilliant discharge will extend from the top of the resonator to about its middle.

The air or oxygen to be ozonised may be fed preferably under pressure to the central portion of the apparatus either by means of the rod T which for this purpose may be hollow and perforated with numerous holes to allow the air to pass into the cylindrical space traversed by the discharge, or by an orifice in the upper wall of the closed chamber enclosing the apparatus, the lower wall then being provided with an outlet orifice.

The output of apparatus when thus used is however necessarily limited by the rapid rise of temperature of the central rod, the coils of the resonator and of the air to be ozonised. To avoid this inconvenience, it is convenient to employ liquid air which is made to flow to the centre of the discharge by employing for the purpose the arrangement illustrated in Fig. 2 of said drawing.

A is a double walled receptacle containing the liquid air which is introduced as required through the upper orifice O. The lower orifice O^1 of the receptacle is partially closed by fibres of asbestos, spun glass, mountain flax, hair or any other porous substance forming a wick B which allows the liquid air to flow in quantity proportional to requirements, the rate of flow being adjustable by stuffing the substance of this wick in the orifice more or less tightly. The relative reduced area of the orifice O may also aid this flow by the excess of pressure on the liquid.

The liquid air will thus descend by capillary action to about midway within the resonator around the central bar T and the discharge will be compelled to traverse the liquid air at the very moment of its expansion.

The space E^1 may be filled up as much as may be desired by di-electric material in order to protect the liquid air receptacle against the direct discharge.

The resonator R is connected in the usual manner to the condensers K and K^1 by the contacts S and S^1, S^1 being the lower spiral of the resonator. This spiral S^1 is also connected to the metal rod T which rises along the axis of the resonator and up the centre of the asbestos wick B to the highest level at which the liquid air expands and becomes gasified.

The discharge takes place between R and the upper end of the rod T and is thus compelled to traverse the layer of air which is still liquid at the very moment of its expansion.

This apparatus presents the following advantages:—

1. Considerable difference in temperature between B and R; an excellent condition for the intense production of ozone.

2. Expansion of the liquid air in the very centre of the discharge and, very probably, owing to the air being then in a transitory state, an easier liberation of the ion O, and of the molecule O_3.

3. Production, by reason of the rod T, of a discharge of very considerable power in relation to the quantity of electricity in use.

4. Action of the discharge upon air very rich in oxygen, as the previous manipulations and transfusions will have already caused the liquid air to lose the greater part of its nitrogen.

The general process described above, consisting in effecting the expansion of the liquid air in the centre of a discharge may be realised by means of several arrangements similar to that which has just been described.

Liquid air can be sent into the centre of the apparatus by any suitable mechanical process other than that described above, and in such case the discharge will be produced in a medium having a temperature that is as low as or is but little higher than—180° C.

If such a low refrigeration be considered useless, and yet it be desired to start with liquid air so as to benefit by its richness in oxygen, this can be done very simply, by placing the liquid air receptacle in the lower part of the apparatus and causing it to rise at the moment of its gasification in the central hollow rod which will form a continuation of the neck of the receptacle; in this case the vacuum between the double wall of the receptacle may be made in such a way as to regulate the output in an invariable manner and to render it more rapid than with the actual Crookes vacuum.

If it be not desired to benefit by the relative richness of liquefied air in oxygen, the operations of liquefaction may not be carried so far and only highly cooled air be sent into the ozonizer as by a Linde or Claude engine, and that always preferably through a central rod located at the axis of the resonator.

There will always however be an advantage in cooling the air to be ozonised as much as possible, the output of the apparatus being all the higher the lower its mean temperature.

If however it be desired not to complicate the apparatus by a liquid air apparatus, the air to be ozonised can be cooled, but much less effectively, by means of a coil located in the central rod and traversed by a current of liquid carbonic dioxide, or liquid sulphurous acid gas (SO_2) at the moment when they again pass from the liquid to the gaseous state, or even of ammonia as in the ordinary ice machines.

In other arrangements of the apparatus of the type above described two resonators may be arranged and such an arrangement will also give excellent results; the combination of two resonators increases the length of the space traversed by the discharge which then occupies the whole height of the resonator carrying the central rod.

Figs. 3 to 7 of the said drawing represent, by way of example, various modifications each having two resonators.

In Fig. 3 the upper spiral of one resonator *r* is connected to the upper spiral of the second resonator r^1 and the rod T is connected to the lowest spiral *a* of the resonator *r*.

In Fig. 4 the upper spiral of *r* is connected to T, the lower spiral *a* to the lower spiral of r^1; this arrangement is particularly advantageous.

Fig. 5 shows an arrangement similar to that in Fig. 1, but the rod T is replaced by a second resonator r^1 of less diameter than the first one *r* and concentric thereto.

In Fig. 6 two concentric resonators are connected as shown in the diagram to two different sources X and Y of high frequency current.

In Fig. 7 the two concentric resonators r and r^1 are arranged in the manner indicated in the figure, the arrangement may however be modified in many ways as regards the position of the condensers X, Y. This arrangement is somewhat similar to the preceding one wherein the two sources of energy are combined to form one only, so to speak.

As in the case of the apparatus described with reference to Fig. 2 all the arrangements which have been mentioned are contained in a closed space having inlet orifices for the air to be treated and outlets for the ozonised air.

The liquid or compressed air is conveyed thereto by any of the means hereinbefore mentioned, so as to be submitted to the action of the discharge.

In the modifications shown in Figs. 5, 6 and 7 the inner resonator r^1 can be formed by a coil serving as a carbon-dioxide, sulphurous acid (SO_2) or ammonia refrigerator, as has been stated in connection with the apparatus shown in Fig. 1.

A number of the apparatus above described may be grouped together to form a battery.

Having now particularly described and ascertained the nature of the said invention and in what manner the same is to be performed I declare that what I claim is:—

1. Apparatus of the type hereinbefore referred to for the production of ozone, in which there is centrally arranged within a resonator a metallic electricity conductor connected to the lower coil of such resonator or to the source of electricity supply to such coil, so that a copious and brilliant discharge of electricity may be caused to extend from the upper portion of the resonator to about its middle portion, substantially as hereinbefore described for the purpose specified.

2. Apparatus of the type hereinbefore referred to for the production of ozone, in which the resonator is furnished with a centrally arranged rod or conductor whereby a powerful and continued discharge of electricity is produced, so permitting of the production of ozone in a considerable quantity, substantially as hereinbefore described with reference to and illustrated by Fig. 2 of the drawings.

3. Apparatus for the production of ozone comprising a resonator with a centrally arranged rod or conductor located in a chamber adapted to receive air to be ozonised, substantially as hereinbefore described with reference to Fig. 1 of the drawing.

4. Apparatus for the production of ozone comprising two resonators and a centrally arranged rod or conductor, substantially as hereinbefore described with reference to and diagrammatically shown in Fig. 3 and in Fig. 4 of the drawing.

5. Apparatus for the production of ozone comprising two resonators arranged concentrically one within the other, substantially as hereinbefore described for the purpose specified.

6. Apparatus for the production of ozone, according to the preceding claims in which the air to be ozonised is delivered in the form of liquid air or compressed air, refrigerated or not, in such a way that the action of the discharge is produced on the air at the moment of its return to the gaseous state or of its expansion, substantially as hereinbefore described.

Dated this 16th day of August 1905

For the Applicant
F. WISE HOWORTH, F.C.S.,
46 Lincoln's Inn Fields, London, W.C.
Chartered Patent Agent.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1905.

[This Drawing is a reproduction of the Original on a reduced scale]

Fig. 1.

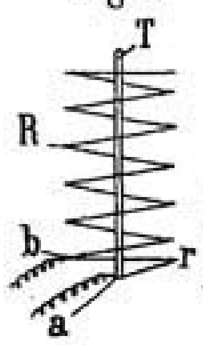


Fig. 3.

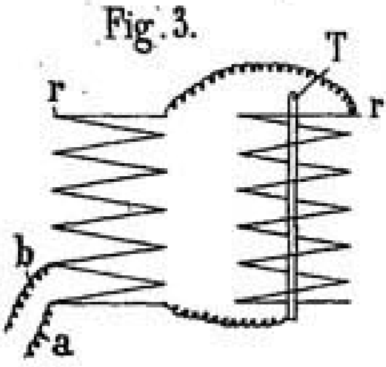


Fig. 4.

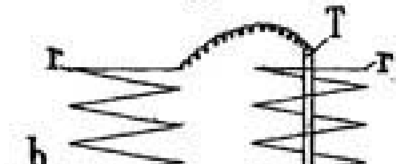


Fig. 5.

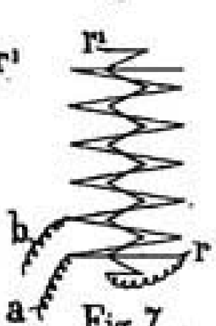


Fig. 6.

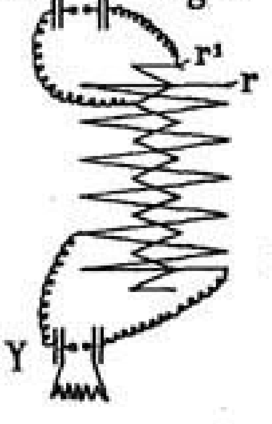


Fig. 7.

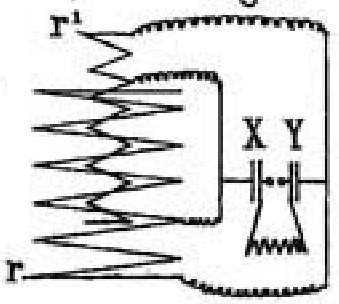
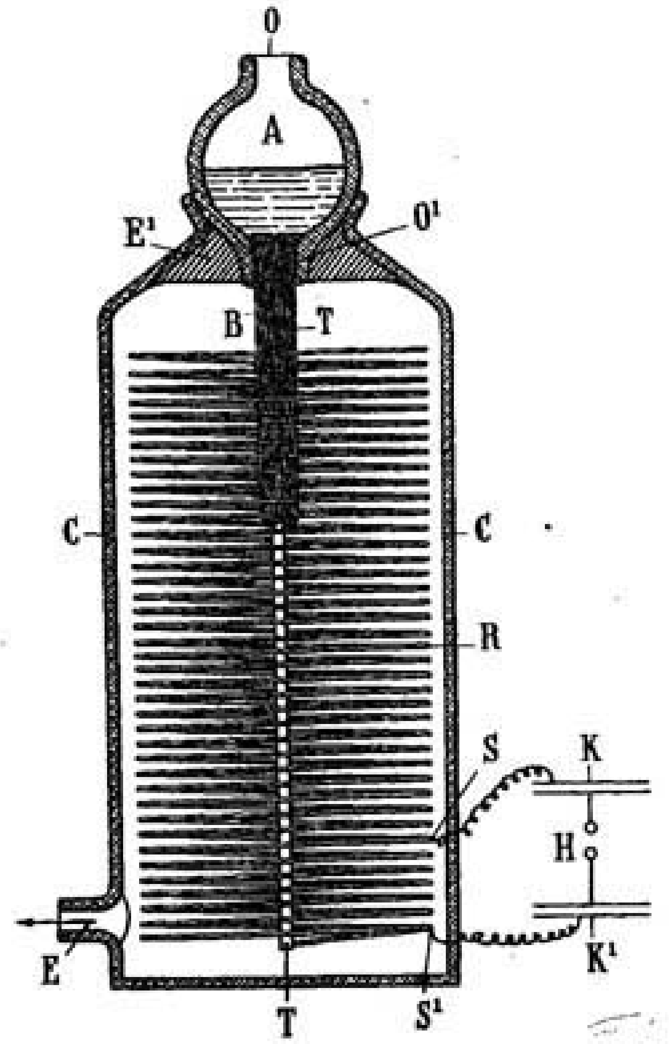


Fig. 2.



Malby & Sons, Photo-Litho.

A.D. 1904. Dec. 23. N° 28,297.
OUDIN'S PROVISIONAL SPECIFICATION.

SHEET 1

[This Drawing is a reproduction of the Original on a reduced scale]

Fig. 1.

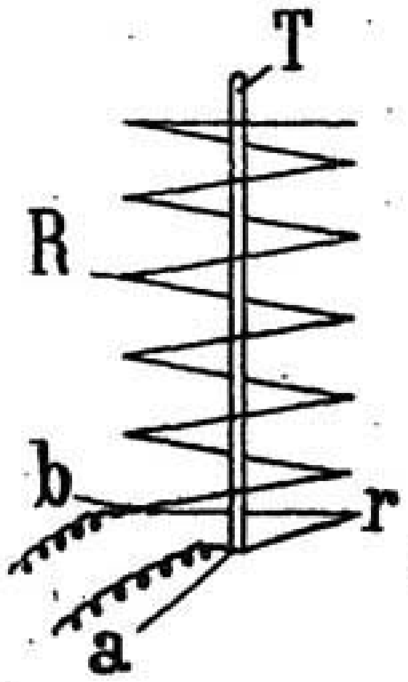


Fig. 3.

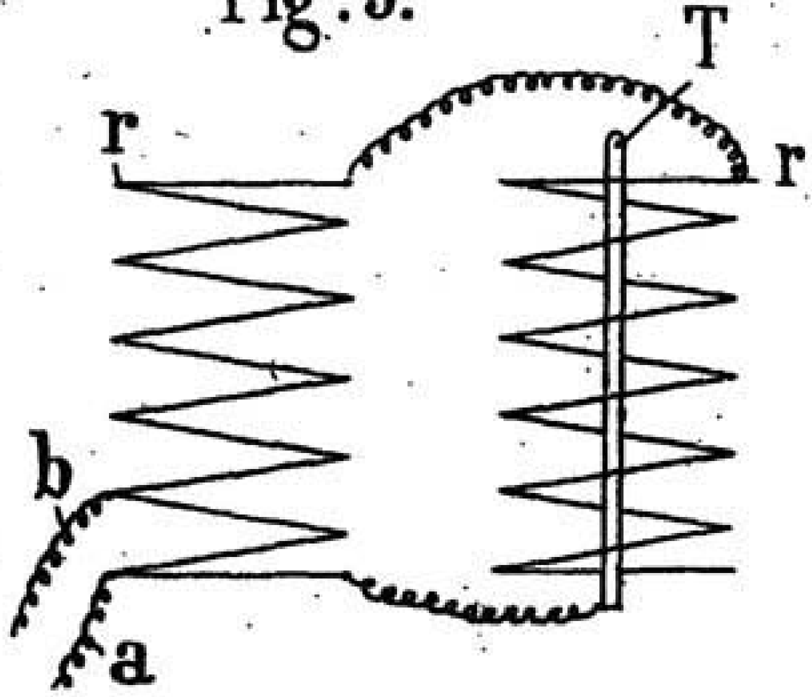


Fig. 4.

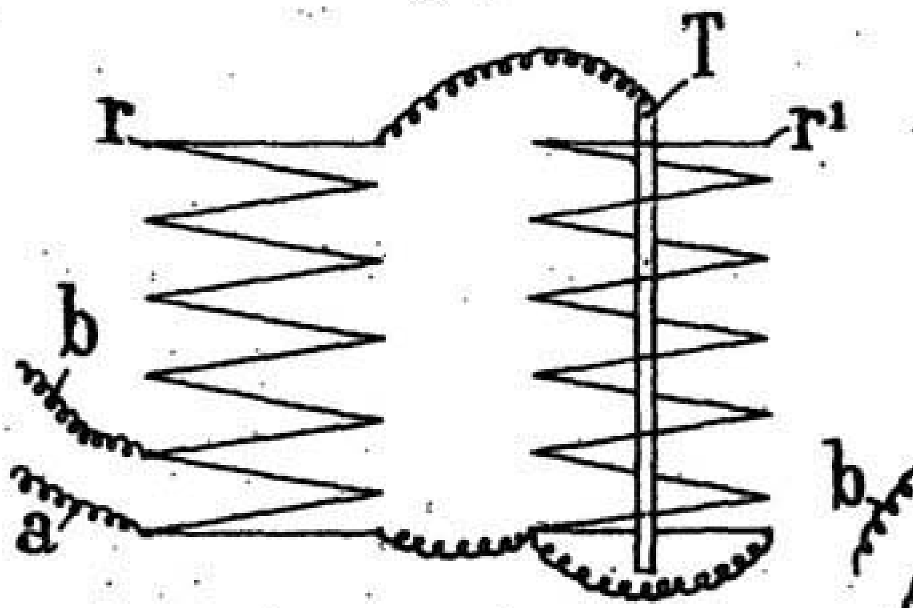


Fig. 5.

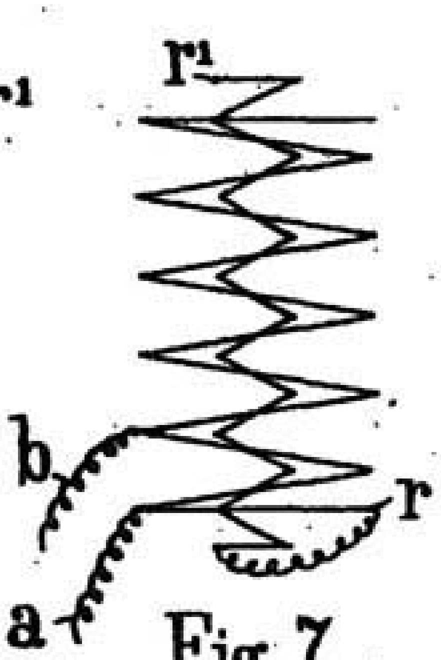


Fig. 6.

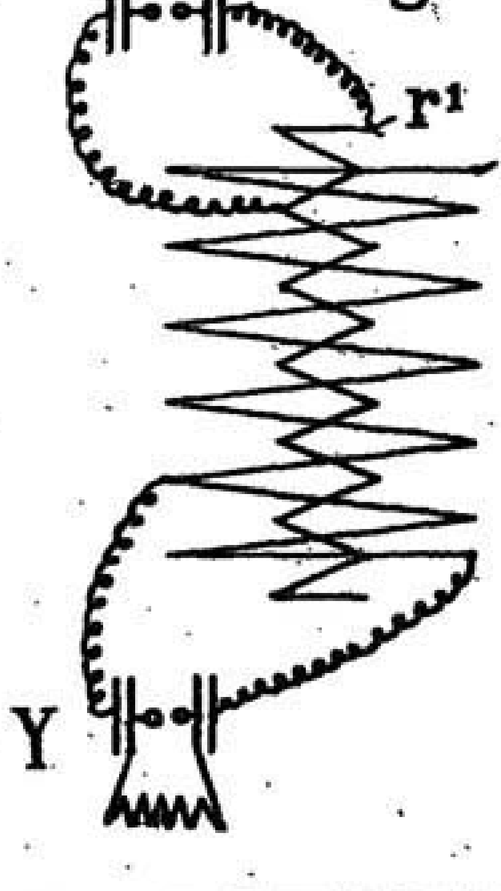
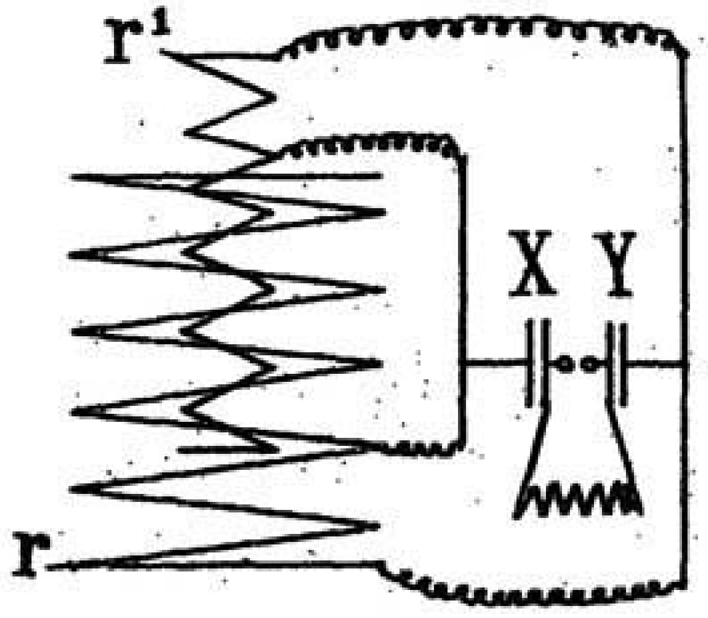


Fig. 7.



Nº 28,297 A.D. 1904

Date of Application, 23rd Dec., 1904

Complete Specification Left, 16th Aug., 1905—Accepted, 21st Sept., 1905

PROVISIONAL SPECIFICATION.

Improvements in Apparatus for the Production of Ozone.

I, Paul Marie Oudin, of 12 rue de Belzunce, Paris, Doctor of Medicine, do hereby declare the nature of this invention to be as follows:—

This invention relates to apparatus for the ozonisation of liquid or gaseous air by subjecting it to a very powerful electrical discharge obtained by the use of apparatus known as the Oudin resonator.

In the industrial application of this apparatus a serious inconvenience occurs owing to the tendency which the electrical influence has to escape from the resonator thus leaving the whole of the central space useless and consequently injurious in consequence of the large quantities of air or oxygen which pass through it without being converted into ozone; on the other hand if the coils of the resonator are wound round a cylinder of wood or other insulating substance, the armature thus formed speedily gets hot and so considerably reduces the output, which, as is well known, is nearly inversely proportional to the temperature of the ozoniser.

Moreover, an Oudin resonator when constructed in the usual way only emits electrical influences at the level of its two or three upper coils. The available zone is therefore small compared with the total volume of the apparatus.

These inconveniences are obviated by arranging the resonator as shewn in the diagram marked Fig. 1 of the accompanying drawing.

In this drawing R is a resonator connected in the usual way at *a* and *b* to a generator of high frequency currents, which may be produced for example by a magneto-electric machine or a Ruhmkorff coil, or an alternator and any industrial transformer. If at the axis of this resonator there is located a metallic conductor T connected to the lower coil of the resonator or to the source of supply of the current to this coil, it will be seen that the electrical influence instead of flowing outward to the resonator, will flash between the coils and the central conductor, and by suitably adjusting the resonator, an extremely copious and brilliant discharge will extend from the top of the resonator to about its middle.

The air or oxygen to be ozonised may be fed preferably under pressure to the central portion of the apparatus either by means of the rod T which for this purpose may be hollow and perforated with numerous holes to allow the air to pass into the cylindrical space traversed by the discharge, or by an orifice in the upper wall of the closed chamber enclosing the apparatus, the lower wall then being provided with an outlet orifice.

The output of apparatus when thus used is however necessarily limited by the rapid rise of temperature of the central rod, the coils of the resonator and of the air to be ozonised. To avoid this inconvenience, it is convenient to employ liquid air which is made to flow to the centre of the discharge by employing for the purpose the arrangement illustrated in Fig. 2.

A is a double walled receptacle containing the liquid air which is introduced as required by the upper orifice O. The lower orifice O^1 of the receptacle is partially closed by fibres of asbestos, spun glass, mountain flax, hair or

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(1 SHEET)

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Fig. 1.

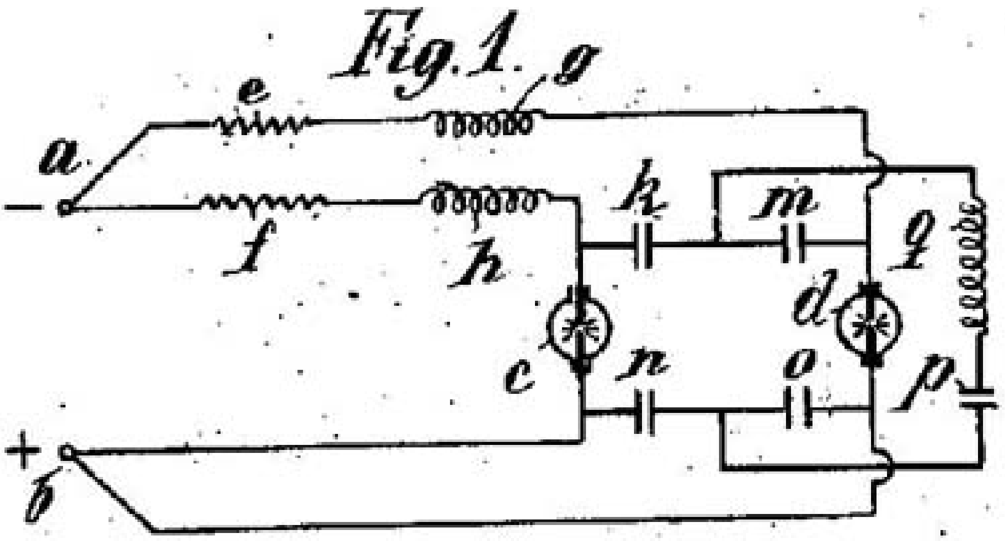


Fig. 2.

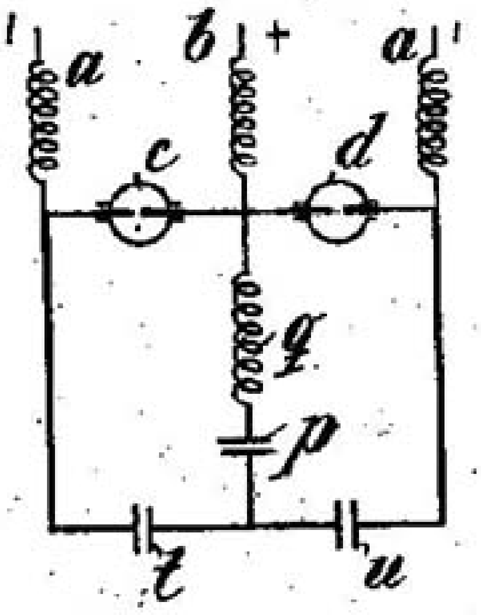
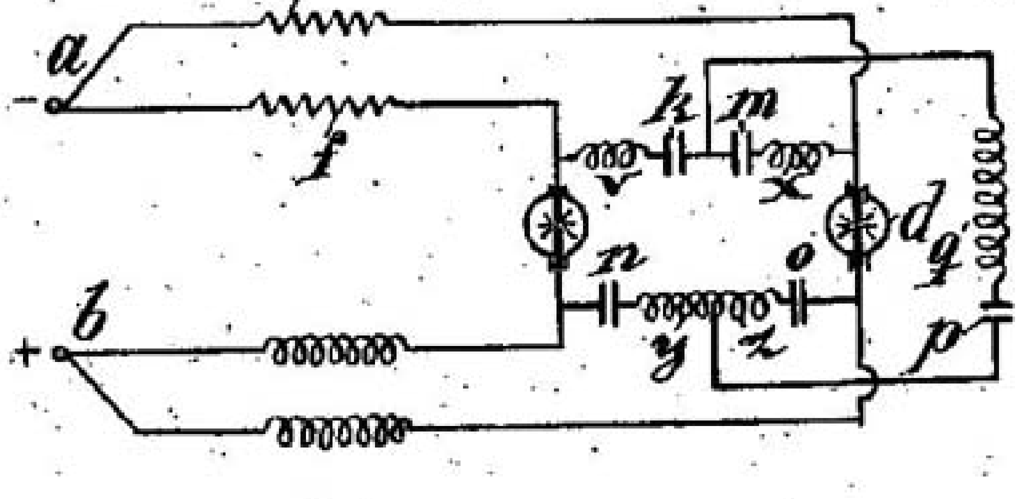


Fig. 3.



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pole of another arc either directly or through capacity-inductance circuits. A connection in multiple, however, would be highly desirable, but a difficulty is found in causing the separate high frequency generators to co-operate in the right manner, whether they be high frequency generators working under use of arcs, spark gaps or the like. If for instance, a Poulsen generator is to be employed for continuous oscillations, provision must be first of all made, whereby all of the generators work in the same phase. This result is difficult to obtain by giving each generator its own circuit of vibration, as would seem to be the most obvious thing to do. With such an arrangement, however, it is difficult to cause all of the generators to work with exactly the same frequency, and when this is not the case variable differences of phase will arise, which will of course be highly disadvantageous. Even if the frequency was exactly the same, it would be necessary to take special measures in order to secure the correct coincidence of phase.

These drawbacks are avoided by causing all of the generators to work inserted in parallel in the same circuit of vibrations. Here, however, another difficulty is presented, for instance in the Poulsen generator, which has the peculiarity that the apparent resistance of the generator decreases when the intensity of the current increases. If, therefore, for some reason or other, an unequal distribution of the high frequency current is effected, a tendency to continuously increase the inequality in the distribution, will be present so that at last the greater part of the current will fall to one of the generators, whereby it becomes less effective, and the aim of the connection in parallel will thus not be attained. Therefore, measures must be taken for securing the equal distribution of the high frequency currents over all of the generators.

It has been proposed to arrange a number of arc generators in parallel with the main circuit of vibration and to provide each arc with a capacity greater than the capacity placed in the main circuit of vibration; these former capacities being intended to keep the arc electrodes of the same sign separated from each other that continuous current should not pass from one electrode to another.

The present invention consists in a method of equalising the distribution of high frequency current in a multiple arrangement of arc generators in parallel in the same circuit of vibration by inserting one or more condensers connected to each arc and in series with the condenser of the main circuit of vibration, the capacity of each of the former condensers being less than the capacity of the latter. The accompanying drawings show embodiments of the arrangement, by which the uniform distribution of the high frequency energy over all of the generators is obtained, according to the present invention. Only two generators are shewn, but of course it is to be understood that three or more can be used, if desired, without departing from the spirit of the invention.

According to the embodiment illustrated in Figure I, *a* and *b* indicate feeding conductors, *c* and *d* two Poulsen generators, *e* and *f* reducing rheostats, *g* and *h* reactance coils, *k*, *m*, *n*, *o* and *p* condensers, and *q* the self induction of the vibration circuit. This latter consists, as will be observed, of the self induction coil *q*, the condenser *p* and the two parallel circuits comprising the condenser *k*, the generator *c* and the condenser *n*; and the condenser *m*, the generator *d* and the condenser *o*, respectively. The capacity of the condensers *k*, *n*, *m* and *o*, (which will most frequently have the same value) must for two reasons be rather small; firstly they will contribute to forcing the high frequency currents running in the circuit of vibration to distribute themselves more evenly over the generators the smaller their capacity is made, and secondly the tendency to produce high frequency currents in the circuit formed by the condenser *k*, the generator *c*, the condensers *n* and *o*, the generator *d* and the condenser *m*, will be the smaller, the smaller the capacity of the condensers is made. This is a circumstance of very great importance. If the condensers *k*, *n*, *o* and *m* are too large, independent high frequency currents will arise in the above named circuit, while the circuit of vibration proper containing the condenser *p*, and the self induction *q* becomes practically devoid of current.

Figure 2 illustrates a somewhat different arrangement for obtaining of the same effect, two auxiliary condensers *t* and *u* only being used.

Figure 3 shows diagrammatically a further embodiment which differs from that shown in Figure 1, only by the insertion of some self induction coils *v*, *x*, *y* and *z*, in connection with the condensers *k*, *m*, *n* and *o*, the insertion of such self induction coils being under certain circumstances advisable, the alteration of the values of one or more of these self inductions for instance presenting a convenient means for effecting the transmission of signals. The signalling (the telegraphy or telephony) may, however, also be effected by alteration of one or more of the values of the capacities of the condensers.

It is to be understood of course, that coupled circuits of vibration, or any other known manner of utilising the energy of the oscillations can be used.

Having now particularly described and ascertained the nature of our said invention, and in what manner the same is to be performed, we declare that what we claim is:—

1. Method of equalising the distribution of high frequency current in a multiple arrangement of arc generators in parallel in the same circuit of vibration by inserting one or more condensers connected to each arc and in series with the condenser of the main circuit of vibration, the capacity of each of the former condensers being less than the capacity of the latter.

2. The multiple arrangements of arc generators and condensers substantially as hereinbefore described and as illustrated in the accompanying drawings.

Dated this 21st day of November, 1913.

HASELTINE, LAKE & Co.,
28, Southampton Buildings, London, England, and
60, Wall Street, New York City, U.S.A.,
Agents for the Applicants.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1915.

Nº 26,834 A.D. 1913

(*Under International Convention.*)

Date claimed for Patent under Patents and Designs Act, 1907, being date of first Foreign Application (in Denmark), *12th Dec., 1912*

Date of Application (in the United Kingdom), 21st Nov., 1913

At the expiration of twelve months from the date of the first Foreign Application, the provision of Section 91 (3) (a) of the Patents and Designs Act, 1907, as to inspection of Specification, became operative

Accepted, 21st Dec., 1914

COMPLETE SPECIFICATION.

Improvements in or relating to Multiple Arrangements of High Frequency Electric Current Generators.

We, Professor Peder Oluf Pedersen, of 1, Amalievej, and Dr. Valdemar Poulsen, Civil Engineer, of 22, Steen Blichersvej, Frederiksberg, both in the Kingdom of Denmark, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to the production of high frequency currents of considerable intensity such as are required for long range radio telegraphy and telephony. Most electric generators for currents of high frequency have the peculiarity that under given circumstances, thus for a given wave-length, feeding tension, and damping they are only able to yield high frequency currents of a limited intensity and this limit is often lower than desirable. It has been attempted to overcome this difficulty by the use of a plurality of generators arranged in series. This method of removing the difficulty is available in cases in which the high frequency circuit may suitably have a rather considerable resistance, the high frequency currents in this case having only a proportionately low intensity, so that no drawbacks of any great importance appear by causing the high frequency currents to pass through all of the generators.

Matters are quite different, however, when the high frequency circuit must necessarily have a low resistance. This is the case for instance in large stations for radio telegraphy and telephony working with great wave-lengths and therefore having a comparatively small resistance of radiation. In such cases, to obtain a sufficient radiation, it is necessary to work with very strong high frequency currents. If, in the case in question, it is found necessary to distribute the high frequency energy over a plurality of generators, a connection in series of these generators will be disadvantageous, as the strong high frequency currents will lessen the effectiveness of the generators.

In order to produce an even train of oscillations it has been proposed to arrange an inductance or a capacity or a connected inductance and capacity as a common branch of two Duddell oscillatory circuits, each end of this common branch being connected to a positive pole of one arc and a negative

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envelope of said tube for changing the rays transmitted through the quartz envelope to ultra-violet rays of longer wave length, common timing means for controlling the energization of said heating means and said tube, and means for controlling the deenergization of the heating means selectively and independent of said timing means.

3. In an ultra-violet ray generator, an electrodeless, gaseous discharge tube, a base, a metal reflector for receiving said tube, combined voltage supplying and mounting terminals carried by the reflector and adapted to contact the tube externally, a support for the reflector and fastened to the base, a high frequency, thermionic tube voltage generating device upon said base and connected to said terminals, and means forming a housing upon said base for enclosing said device, said housing means being of sheet metal to provide a high frequency electric shield to minimize transmission of radio interfering, high frequency currents.

4. In an ultra-violet ray generator, an elongated, gaseous discharge tube, a base, a frame fastened to the base, a reflector adjustably mounted on said frame, said reflector comprising an elongated sheet metal shell of generally parabolic configuration in cross-section and having an inner reflecting surface, resilient clips mounted in the bottom of said reflector shell in spaced relation longitudinally of the shell and adapted to clamp the tube externally, and means mounted on the base and connected to said clips for supplying high frequency energizing current to said tube.

5. In a therapeutic lamp, a gaseous discharge tube having a quartz envelope, means for supplying current to said tube to operate the tube as a cold quartz ultra-violet ray generator emitting rays of one wave length band, and means for heating the quartz envelope of said tube to cause the tube to operate as a hot quartz ultra-violet ray generator emitting rays of a different wave length band and including ultra-violet rays of longer wave length than in the first band.

6. An ultra-violet ray generator comprising an elongated reflector shell of generally parabolic configuration in cross section, and closed at its opposite ends, an elongated ultra-violet ray tube, means for supplying current to said tube, said means comprising lead-in wires extending along the bottom of the reflector shell, a channel-shaped member overlying said wires to house the same, a pair of resilient clips mounted on said channel-shaped member and connected within the channel-shaped member to said lead-in wires, said clips being constructed to detachably receive and resiliently clamp said tube, said clips having portions engaging the ends of the tube to prevent longitudinal movement of the tube in the clips.

7. An ultra-violet ray generator comprising an elongated reflector shell, an ultra-violet ray tube, means for supplying current to said tube and comprising lead-in wires extending longitudinally of the shell, lamp receiving members mounted in said shell and spaced longitudinally thereof to mount the tube in the shell, connections between said members and said lead-in wires whereby said members also serve as supply terminals for said tube, a generally U-shaped mounting standard for said shell, a link positioned between said legs and pivoted at one end adjacent the cross piece of the U-shaped standard, said link being pivotally connected at its other end to said shell, the legs of said U-shaped standard being spaced apart by said cross piece sufficiently to accommodate the shell and the link therebetween, the pivoted link permitting swinging of the shell through the standard from one side to the other in various angular positions with relation to the plane of the standard.

8. An ultra-violet ray generator comprising a base, a frame of generally inverted U-shape in elevation and mounted on said base, a pair of links pivoted at corresponding ends to the legs of the frame and adapted to extend parallel to said frame legs, an elongated reflector shell of general parabolic configuration in cross section, means pivoting said shell to the other corresponding ends of said links, said links and said shell being positioned between said frame legs and said frame legs being spaced apart sufficiently to accommodate said links and said shell for angular adjustment to either side of said frame and parallel to said frame legs and at various angles to the plane of said legs.

9. In an ultra-violet ray generator, a base, a frame of generally inverted U-shape in elevation and mounted on said base, a high frequency supply circuit including high frequency generating elements mounted on said base, a sheet metal housing for said elements secured to said base and having openings therein in which the legs of said frame extend, an elongated reflector shell positioned between the legs of said frame, a supporting member for said shell positioned between said frame legs, means pivoting said member to one of said frame legs, means spaced longitudinally of the frame from said first pivoting means for pivoting said shell to said member, an electrodeless ultra-violet tube, supply leads extending from said supply means within said housing, through said housing, and along the bottom of said shell, resilient clips for receiving and clamping said tube and supplying high frequency current thereto, a member extending longitudinally of said shell in the bottom thereof for housing said supply leads, and means for mounting said clips on said housing member in spaced relation longitudinally of said shell.

10. In a therapeutic lamp, an electrodeless, elongated, gaseous discharge tube adapted to provide therapeutic rays, an elongated, generally semi-cylindrical reflector, lead-in wires extending along the internal surface of the reflector, means forming with said surface of the reflector a housing for said wires, and tube mounting terminals connected to said wires, said terminals being carried by said housing means and projecting inwardly of the reflector from said means and spaced longitudinally of the reflector.

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FIG. 4.

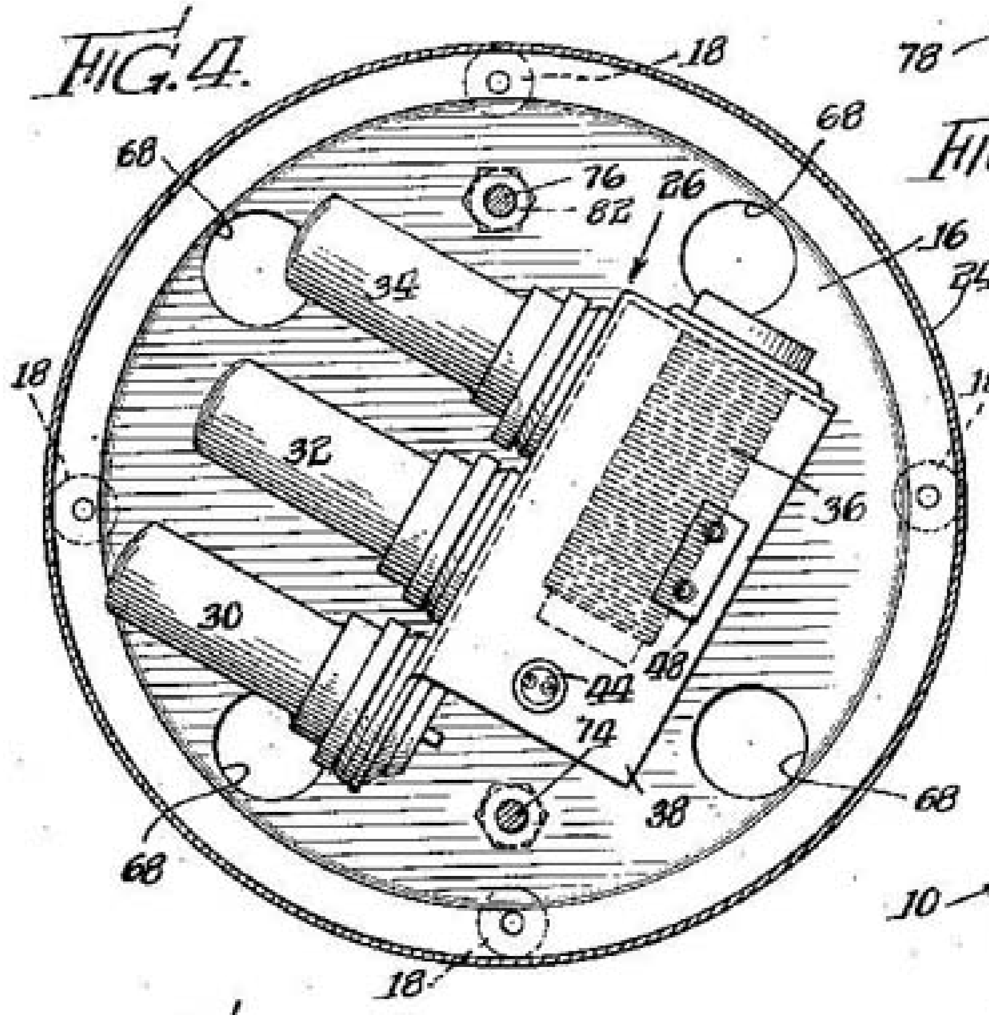


FIG. 5.

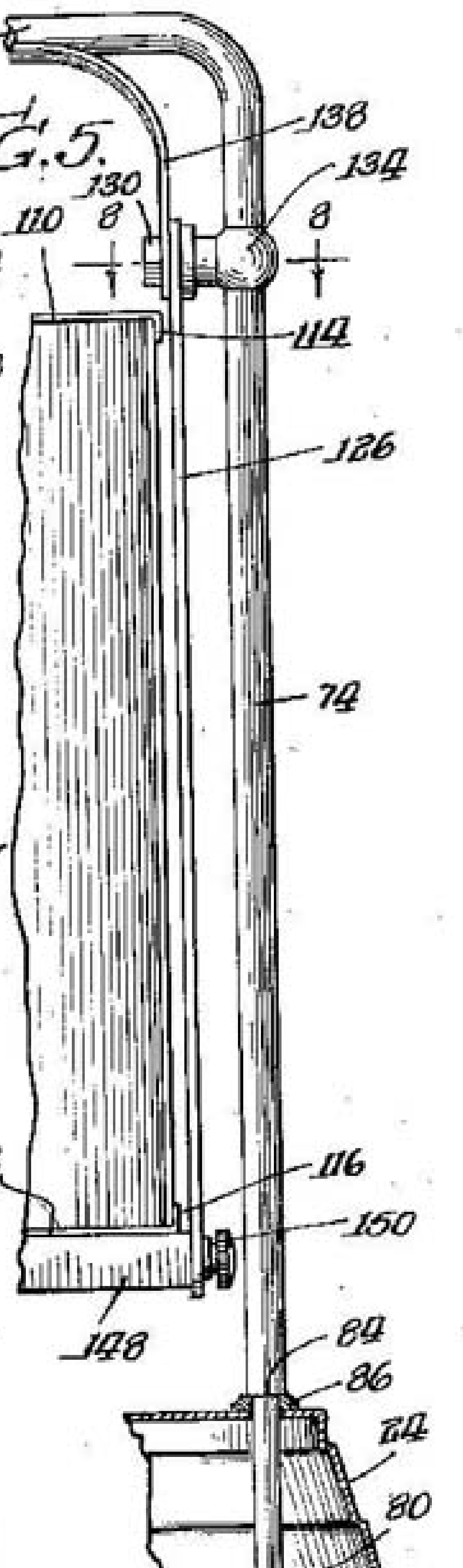


FIG. 6.

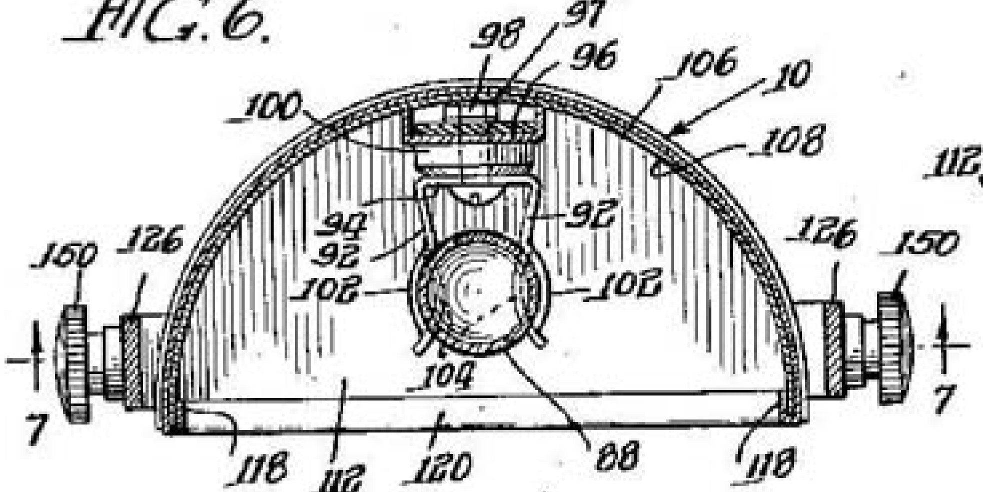


FIG. 7.

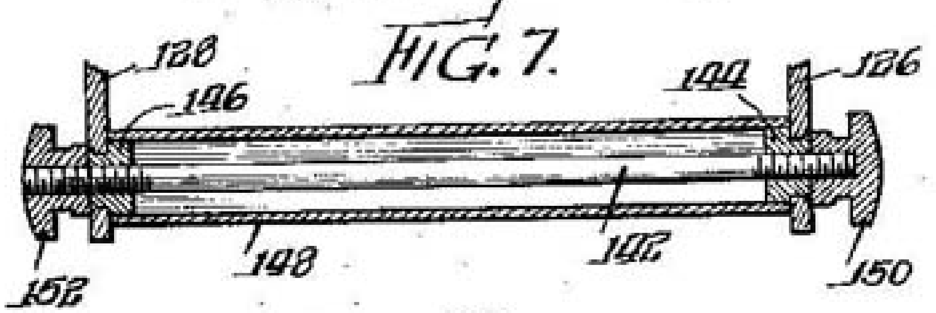
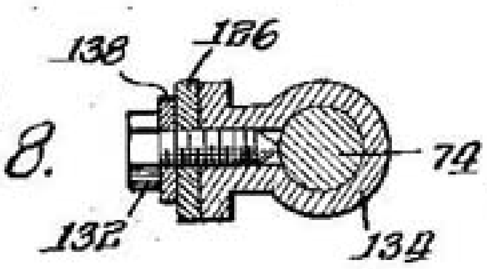


FIG. 8.



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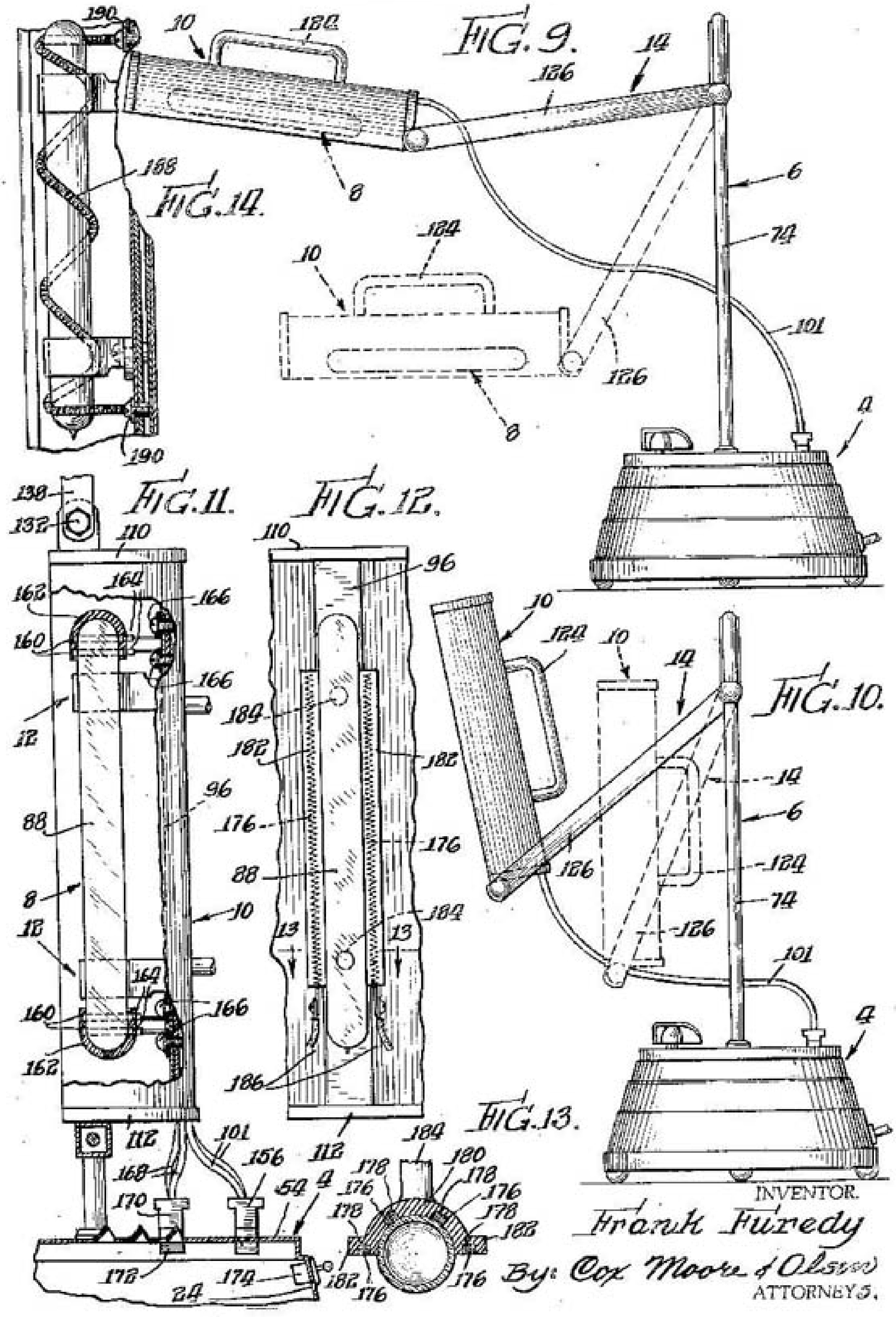

FIG. 9.

FIG. 10.

FIG. 11.

FIG. 12.

FIG. 13.

FIG. 14.

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UNITED STATES PATENT OFFICE

2,327,346

THERAPEUTIC LAMP

Frank Furedy, Chicago, Ill., assignor to Sun-Kraft, Inc., Chicago, Ill., a corporation of Illinois

Application July 24, 1940, Serial No. 347,257

10 Claims. (Cl. 250—88)

This invention relates to an ultra violet generator or therapeutic lamp.

It is an object of this invention to provide a compact, highly efficient therapeutic lamp serving as an ultra violet ray generator and as an ozone generator.

A further object of the invention is to provide an ultra violet ray generator or a lamp, or a combined ultra violet and ozone generator, in which the bulb mounting clips or means serve also as electric supply terminals for the bulb and although exposed, will not injure or even shock a person coming in contact with these supply terminals.

A further object of the invention is to provide an ultra violet ray generator in which the lamp bulb or gaseous discharge tube contains no internal electrodes and is mounted in electric terminals supplying electricity to the gas within the tube through the walls of the tube.

A further object of the invention is to provide in a therapeutic lamp of the above stated character a reflector of high efficiency for an ultra violet lamp bulb or gaseous discharge tube of elongated form.

It is a further object of the invention to provide a therapeutic lamp serving as an ultra violet ray generator and ozone generator capable of energization by a high frequency voltage of relatively low current intensity and wherein the means for supplying this high frequency voltage is mounted in a housing formed by the parts of the lamp which parts also act to electrically shield such current supplying means and are provided with means permitting a circulation of air about such supplying means and through said housing parts.

Applicant's invention further has as an important object the provision of lamp mounting means which are inexpensive from a manufacturing standpoint, but provide a great flexibility of adjustment so that the lamp may be readily adjusted to any desired angle and also to any desired elevation within a predetermined range.

Applicant's invention also contemplates the provision in a therapeutic lamp of a pure quartz ultra violet supplying lamp bulb or gaseous discharge tube and means for selectively controlling the lamp bulb or tube for use as a cold quartz lamp supplying pure ultra violet rays or as a hot quartz lamp supplying ultra violet rays of longer wave length and infra red or heat rays for simultaneous therapeutic application.

The invention also contemplates inexpensive and efficient means for mounting the heating means in relation to the quartz lamp to supply heat to the lamp.

Other and further objects and advantages of the invention will be apparent from the following description when taken in connection with the accompanying drawings wherein:

Fig. 1 is a view in perspective of a cold quartz therapeutic lamp constructed in accordance with the invention;

Fig. 2 is an enlarged vertical section taken substantially along the line 2—2 of Fig. 1;

Fig. 3 is a fragmentary view in horizontal section taken along the line 3—3 of Fig. 2;

Fig. 4 is a horizontal section taken substantially along the line 4—4 of Fig. 2;

Fig. 5 is a fragmentary view in vertical section taken along the line 5—5 of Fig. 1;

Fig. 6 is an enlarged horizontal section taken substantially on the line 6—6 of Fig. 1;

Fig. 7 is a fragmentary vertical section taken along the line 7—7 of Fig. 6;

Fig. 8 is a fragmentary enlarged view taken in horizontal section along the line 8—8 of Fig. 5;

Figs. 9 and 10 are diagrammatic views in elevation illustrating the adjustment of the reflector and the lamp bulb mounted therein;

Fig. 11 is a fragmentary view in elevation and partly cut away illustrating a hot and cold quartz lamp embodying the invention;

Fig. 12 is a fragmentary face view in elevation showing a modified form of heater mounting for the lamp;

Fig. 13 is a fragmentary view in horizontal section taken along the line 13—13 of Fig. 12; and

Fig. 14 is a fragmentary view in elevation of another modified form of heater for the lamp.

As shown in Figs. 1 to 10, a therapeutic lamp 2 embodying the invention comprises a base portion 4, a frame 6, an ultra violet lamp bulb or gaseous discharge tube 8, a high efficiency reflector 10, combined mounting means and electric supply terminals or electrodes 12 and adjustable mounting means 14 for mounting the reflector 10 and bulb or tube 8 on the frame 6.

The base portion 4 comprises a relatively heavy disc-shaped base casting 16 having depending feet 18 formed of suitable cushioning material and secured to the base 16 as by screws 20 threaded into the annular thickened rim 22 of the base plate 16. The base portion 4 also comprises a sheet metal shell 24 of frusto-conical shape secured to the base plate 16 by the frame 6 as will presently appear. The shell 24 and base plate 16 cooperate to form a housing for the high frequency generating and current supply means 26 and a timing mechanism 28.

The high frequency generating and current supplying means 26 comprises a ballast tube 30 (Figs. 2 and 4), a thermionic rectifying diode or thermionic rectifying and voltage doubling duodiode tube 32, a thermionic power amplifier tube 34, and an air core induction coil 36. The tubes 30, 32 and 34 are mounted upon a sheet metal base 38 fastened in a convenient manner to the base plate 16. The induction coil 36 is connected in an oscillating circuit with the power amplifier tube 34, and the tube 34 is connected to the tubes 30 and 32 as described in my co-pending application Serial No. 347,258, filed July 24, 1940, now issued as Patent No. 2,300,916, dated September 25, 1942.

The timing mechanism 28 may be of any suitable conventional character, preferably embodying a simple form of mechanical clock embodying an electric switch that is closed by the setting of the clock and is opened upon the elapsing of a period for which the clock is set. The switch of the timing mechanism 28 is connected in the supply cable or cord 40 to control the supply of power through the plug 42 to the power input socket 44 of the high frequency current supply means 26.

The output socket 46 of the high frequency current supply means 26 is connected by a plug 48 and wires 50 to a socket 52 secured to the upper wall 54 of the shell 24. A dial plate 56 for the timing mechanism 28 is mounted in a circular groove formed by a depressed portion 58 of the upper wall 54 of the shell 24 and is fastened to the shell as by the screws 60 which also fasten the timing mechanism to the shell. The time setting shaft 62 of the timing mechanism 28 extends through openings in the wall portion 58 of the shell and in the dial plate 56 and at its outer end carries an operating knob 64 formed with a pointer portion 66 for cooperation with the indicia on the dial plate 56.

The base plate 16 is provided with a plurality of angularly spaced openings 68 of which there may be any desired number, which form air inlet passages into the base portion 4. The upper wall 54 of the shell 24 is formed with a plurality of struck-up portions or louvres 70 which form ventilating openings or air outlet passages 72 cooperating with the air inlet passages 68 to provide means for permitting a sufficiently rapid circulation of air sufficiently large in volume to dissipate the heat supplied by the inherent heating effect of the tubes 30, 32 and 34 and to maintain the shell 34 in a relatively cool condition.

The shell 24 not only cooperates with the base to form a housing for the high frequency generating or current supply means 26 and the timing mechanism 28, but also being of sheet metal, acts as an electrical shield minimizing radio interference effects of the supply means 26 which generates currents of approximately 550 kilocycles. It has been found that the shell 24 acting as an electrical shield so minimizes radio interference effects of the current supply means 26 that such effects are only slightly noticeable even in the same house circuit in which the lamp 2 is connected and are not noticeable in radio receiving sets connected in other house circuits or placed any appreciable distance from the lamp 2.

The frame 6 is preferably composed of a round rod or bar of inverted U-shaped configuration and having spaced legs 74 and 76 and a substantially perpendicular connecting portion 78. Reduced free end portions 80 (Fig. 5) of the legs 74 and 76 pass through openings in the upper wall 54 of the shell 24 and through countersunk openings in the base plate 16. Suitable fastening means as nuts 82 on the free ends of the legs 74 and 76 secure the frame 6 to the base plate 16. The frame 6 also serves to fasten the shell 24 to the base plate 16 where the reduced portions 80 of the legs 74 and 76 form shoulders 84 overlying retaining washers 86 interposed between the shoulders and the upper wall 54 of the shell 24.

The ultra violet lamp or gaseous discharge tube 8 comprises an electrodeless pure quartz ultra violet ray transmitting envelope 88 exhausted to a relatively high vacuum; filled with mercury vapor; small quantities of argon, helium, krypton and neon gases, a globule 90 (Fig. 2) of mercury and then sealed off. It will be seen that the bulb or tube 8 has no internal electrodes and hence may be termed electrodeless.

High frequency voltage which activates or energizes the vapor and gas within the tube is applied to the tube by the combined mounting means and terminals or external electrodes 12. Excitation of the lamp being by a high frequency voltage of relatively low current, a person will receive no shock by touching the electrodes. The combined mounting means and terminals 12 comprise a pair of spaced, generally U-shaped spring metal clips having opposed resilient legs 92 (Fig. 6) and an interconnecting base or mounting portion 94. The terminals 12 are mounted on a sheet metal channel 96 by bolts 98, insulating strips 97 and insulating bushings 100; the bushings 100 insulating the terminals 12 from the channel 96, the strips 97 insulating the screws 98 from the channel 96 and the screws 98 forming means for connecting the wires 101 which pass between the strips 97 to the terminals 12. In the form shown in Figs. 1 to 10, the legs 92 of each terminal 12 are formed with outwardly pressed portions 102 having their concave sides facing inwardly so that the legs 92 snugly embrace and frictionally grip the lamp bulb or tube 8 as shown in Fig. 6. Inwardly pressed portions 104 having their convex sides facing inwardly are formed in the legs 92 of the terminals 12 above the portion 102 in the case of the upper terminal and below the portion 102 in the case of the lower terminal so as to overlie the rounded end of the envelope 88 and positively hold the lamp bulb or tube against longitudinal movement.

The terminals 12 mount the lamp bulb or discharge tube in the reflector 10 which comprises superposed elongated sheet metal members 106 of parabolic form in cross-section, the inner member being provided, as by chromium plating, with a highly reflecting internal surface 108. Top and bottom sheet metal caps 110 and 112 of parabolic form are provided with edge flanges 114 and 116 respectively to snugly embrace and receive the upper and lower edges of the member 106. If desired, the flanges 114 and 116 may be welded to the outer surface of the member 106. The forward free edges of the outer member 106 are crimped or bent inwardly as at 118 to provide a smooth edge; to secure the members 106 together; and for interlocking with the inturned edge flanges 120 of the caps 110 and 112 to hold the reflector parts in assembled relation.

The channel 96 which carries the bulb or tube mounting means and terminals 12 and receives the wires 102 is positioned within the reflector member 106 centrally thereof and is fastened to the reflector member as by the screws 122 (Fig. 2) that also fasten a handle 124 to the reflector member 106. The channel 96 preferably extends the full length of the reflector member 106 and abuts the end caps 110 and 112. The forward face of this channel member 96 is preferably chromium plated or otherwise provided with a high reflecting surface for the forward reflecting of the ultra violet rays received through the rear portion of the quartz envelope 88 of the lamp bulb or tube 8.

If desired, the channel 96 may be formed as an integral part with the reflector member 106 and the rearwardly opening channel thus formed closed by a separate piece or strip.

The adjustable mounting means 14 for the lamp bulb or tube 8 and its reflector 10 comprises a pair of elongated parallel straps or bars 126 and 128 pivotally secured at their upper ends to the frame 6 as by cap screws 130 and 132 respectively which are received in and clamp the sockets 134 and 136 to the legs 74 and 76 of the frame 6.

The cap screws 130 and 132 also secure a frame re-enforcing strap 138 to the sockets 134 and 136. The strap 138 is preferably of metal and of inverted U-shape in configuration. The transverse portion 140 of the strap 138 is bowed as shown in Fig. 2 to embrace the cross bar portion 78 of the frame 6. The strap 138 also serves to prevent rotation of the cap screws 130 and 132 as the straps 126 and 128 are pivoted on these screws to adjust the reflector to different positions. This resistance to turning of the cap screws 130 and 132 is of course achieved by reason of the frictional binding of the heads of the screws against the strap 138. The cap screws 130 and 132 which are pointed (Fig. 8) are of course drawn up sufficiently to clamp the sockets 134 and 136 to the upright legs of the frame 6 and to frictionally bind the straps 126 and 128 in every adjusted position.

The reflector 10 is disposed between the parallel straps or bars 126 and 128 and is pivotally connected thereto for rotatable adjustment about a horizontal axis at any desired angle relative to the bars 126 and 128. The means for forming this pivotal connection comprises a rod 142 (Fig. 7) received in bushings 144 and 146 carried by the bars 126 and 128. The bushings 144 and 146 are mounted in aligned openings adjacent the lower ends of the bars 126 and 128 and are secured thereto as by upsetting or peening over the outer edges of the bushings. A reflector mounting member 148 of substantially rectangular shape in cross-section is fastened to the cap member 112 of the reflector 14 in any convenient manner, as by welding. This rectangular reflector mounting member 148 extends between the parallel bars 126 and 128 and is journalled on the inwardly extending portions of the bushings 144 and 146. Knurled thumb nuts 150 and 152 are received on the opposite threaded end portions of the rod 142 and serve to frictionally clamp the parallel bars 126 and 128 against the opposite edges of the reflector mounting member 148 so that this mounting member and the reflector carried thereby may be adjusted as desired about the axis of the rod 142 and frictionally held in every adjusted position. The threaded opening in one of the thumb nuts as for example, the thumb nut 152, may extend entirely therethrough so as to permit this adjusting thumb nut to be drawn up to any desired degree.

Figs. 9 and 10 illustrate in full and dotted lines the manner in which the parallel mounting bars 126 and 128 may be adjusted about the common axis of the cap screws 130 and 132 to position the reflector 10 and the lamp bulb or tube carried thereby at different angular positions and distances relative to and from the frame 6. These figures also illustrate the manner in which by grasping of the handle 124 the reflector 10 and the tube may be rotatably adjusted about the axis of the rod 142 to different angles relative to the parallel bars 126 and 128.

It will be further evident that by manipulation of the handle 124, the reflector and tube may be rotated through the complete range of 360 degrees about the axis of the rod 142 so that the rays from the lamp bulb or tube may be directed upwardly or downwardly, forwardly or backwardly, or at any desired angle between these positions as may be most convenient for treatment of the patient or object. It will also be evident that the mounting bars 126 and 128 may be adjusted through a range approximating 360 degrees. In an actual construction this range of swing of the bars 126 and 128 with the sockets 134 and 136 positioned as shown in Fig. 1 equals about 330 degrees. By loosening the cap screws 130 and 132, the sockets 134 and 136 may be moved downwardly of the frame 6 and the angle of swing of the bars 136 further increased as desired. This permissible adjustment of the sockets 134 and 136 on the frame 6 also permits a very wide latitude of vertical adjustment in elevation of the reflector and its parallel mounting bars.

From the above it will be seen that by reason of the reflector mounting means in which the lamp bulb or tube is carried, a great flexibility of adjustment is provided to position the bulb or tube and its reflector at practically any desired elevation or angle. For angular adjustment about a vertical axis, the entire structure may of course be shifted on its supporting surface about such an axis. The base plate 16 of the frame structure may be provided with a central threaded opening 154 for mounting on the upright column of a floor stand provided with mating threads at the upper end of the column.

As shown in Fig. 2, the wires 101 which pass into the channel 96 through an opening in the bottom plate 112 of the reflector carry at their lower ends a plug 156 by which said wires may be connected to the socket 52. These wires 102 may be of any suitable fine, well-insulated wire of high flexibility and are preferably maintained in spaced relation by spacing pieces of insulating material which prevent twisting of the wires about each other and minimize electro-magnetic interaction between the wires. These wires are of course of sufficient length to permit the reflector and the bulb or tube carried therein to be adjusted to any of its manifold possible positions relative to the frame 6.

The clips 12, having a high frequency voltage applied thereacross, produce a copious supply of ozone and this is enhanced by the ozonizing action of the rays.

As shown in Fig. 11, the cold quartz lamp of Figs. 1 to 10 may be converted into a selectively hot or cold quartz lamp by one or more sets of heating elements 160 preferably composed of coils of fine nichrome wire, which coils snugly embrace the quartz envelope 88 adjacent an end thereof. As shown in Fig. 11, two such sets of heating elements 160 are provided adjacent opposite ends of the envelope 88. Each set of heating elements may be mounted in annular recesses in the inner surface of a cap 162 fitting the end of the quartz envelope 88. The cap 162 may be of metal or of insulating material. If of metal, it is preferably of one having a relatively low coefficient of heat conductivity so that while a relatively large quantity of infra red or heat rays may irradiate from the cap, it is sufficiently non-conductive of heat to permit the proper heating of the quartz envelope 88 necessary to the generation and transmission of rays characteristic of a "hot quartz lamp." If the cap 162 be composed of insulating material, it is preferably of Bakelite or ceramic substance so that substantially all of the power of the heating element is utilized to heat the quartz envelope 88. Terminals 164 for the sets of heating elements 160 extend through the rear of the caps 162 and are connected directly or by short leads to terminal screws or members 166 mounted on the channel 96 and insulated therefrom as by insulating bushings similar to the bushings 100 (Figs. 2 and 6).

The terminals 164 of the upper and lower sets of heating elements are connected in parallel by wires 168 passing through the channel 96 and carrying a plug 170 by which the wires may be connected to a power supply socket 172 mounted in the shell 24 and secured to the upper wall 54 thereof. The power supply socket 172 may be connected to the supply cable or cord 40 through a control switch 174 and the switch of the timing mechanism 28 as described in my previously mentioned co-pending application so that upon closing of this switch 176, the heating elements 160 are energized under the control of the switch of the timing mechanism 28 and the lamp may then be used as a "hot quartz lamp." Upon opening of the manual switch 174, the circuit to the sets of heating elements 160 will be broken as described in said co-pending application so that the lamp may be used as a "cold quartz lamp" providing a source rich in substantially pure ultra violet rays, that is a source reached in ultra violet rays of 2537 Angstrom units.

As shown in Figs. 12 and 13, the sets of heating elements 176 which are preferably composed of fine nichrome wire in elongated helixes are received in forwardly opening recesses 178 formed in an elongated mounting member 180 of generally semi-cylindrical configuration and provided with opposed lateral wings 182. Rearwardly projecting stud portions 184 receive mounting screws (not shown) by which the mounting member 180 is fastened to the channel member 96. The sets of heating elements 176 are connected in series and current is supplied thereto through leads 186 which connect the heating element to terminal screws similar to the terminal screws 166 and similarly mounted on the channel member 96. It will be seen that with the heating elements mounted as shown in Figs. 12 and 13 in the mounting member 180 which may, like the caps 162, be formed of metal or insulating material, the heating means supplies a relatively large quantity of infra red or heat rays as well as a sufficiently large amount of heat for causing the lamp bulb or discharge tube 8 to operate as a "hot quartz lamp."

In the form shown in Fig. 14, the heater coil 188 is wound as a helix directly upon the envelope 88 of the lamp and is connected at its opposite ends to terminal screws 190 mounted similarly to the terminal screws 166.

It will be apparent from the foregoing description that applicant has provided a compact, highly efficient therapeutic lamp serving as an ultra violet ray generator and as an ozone generator.

Applicant has also provided an ultra violet ray generator or lamp, or a combined ultra violet and ozone generator, in which the bulb mounting clips or means serve also as electric supply terminals for the bulb and although exposed, will not injure or even shock a person coming in contact with these supply terminals.

Applicant's invention also provides an ultra violet ray generator in which the lamp bulb or gaseous discharge tube contains no internal electrodes and is mounted in electric terminals supplying electric energy for excitation of the gas within the tube through the walls of the tube.

The invention has also provided in a therapeutic lamp of the above-stated character a reflector of high efficiency for an ultra violet lamp bulb or gaseous discharge tube of elongated form.

Applicant has also provided a therapeutic lamp serving as an ultra violet ray generator and ozone generator capable of energization by a high frequency voltage of relatively low current intensity and wherein the means for supplying this high frequency voltage is mounted in a housing formed by the parts of the lamp which parts also act to electrically shield such current supplying means and are provided with means permitting a circulation of air about such supplying means and through said housing parts.

Applicant has further provided a lamp mounting means which is inexpensive from a manufacturing standpoint, but provides a great flexibility of adjustment so that the lamp may be readily adjusted to any desired angle and also to any desired elevation within a predetermined range.

Applicant's invention has also provided in a therapeutic lamp a pure quartz ultra violet supplying lamp bulb or gaseous discharge tube and means for selectively controlling the lamp bulb or tube for use as a cold quartz lamp providing a source rich in pure ultra violet rays, or as a hot quartz lamp providing less pure ultra violet rays of longer wave length and infra red or heat rays for simultaneous therapeutic application.

The invention has further provided inexpensive and efficient means for mounting the heating means in relation to the quartz lamp to supply heat to the lamp bulb.

It is obvious that various changes may be made in the specific embodiments of the invention set forth for purposes of illustration without departing from the spirit of the invention. Accordingly the invention is not to be limited to the specific embodiments shown and described, but only as indicated in the following claims.

The invention is hereby claimed as follows:

1. In a therapeutic lamp, a gaseous discharge tube having a quartz envelope and adapted to provide ultra-violet rays, means for supplying current to said tube to produce ultra-violet rays of one wave length band, means for producing infra-red rays, said infra-red ray producing means being positioned in relation to the tube envelope to heat the quartz envelope of the tube whereby to change the rays transmitted through the quartz envelope of the tube to ultra-violet rays of longer wave length.

2. In a therapeutic lamp, a gaseous discharge tube having a quartz envelope and adapted to provide ultra-violet rays, means for supplying current to said tube to produce ultra-violet rays of one wave length band, means for heating the

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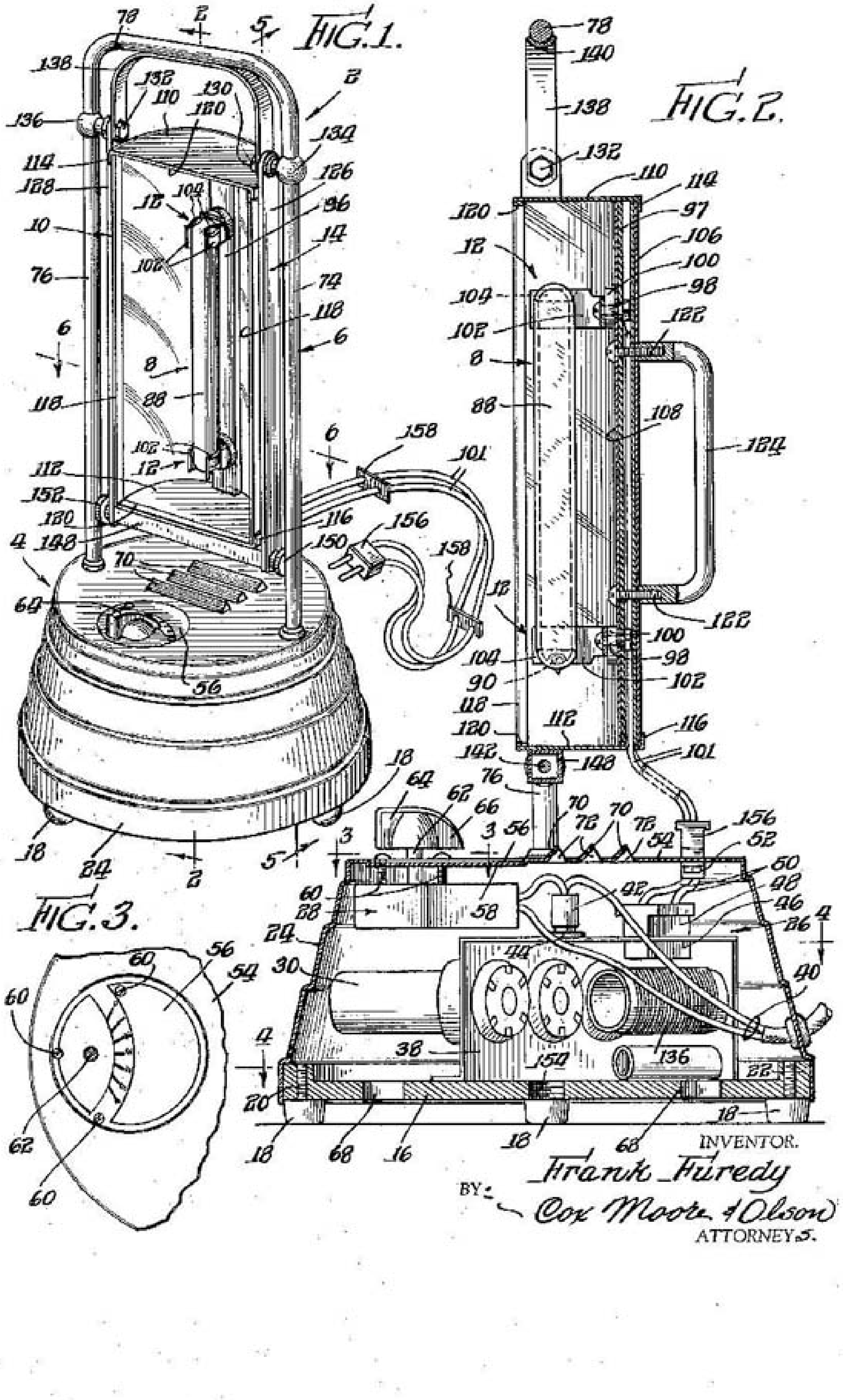

FIG. 1.

FIG. 2.

FIG. 3.

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[This Drawing is a reproduction of the Original on a reduced scale.]

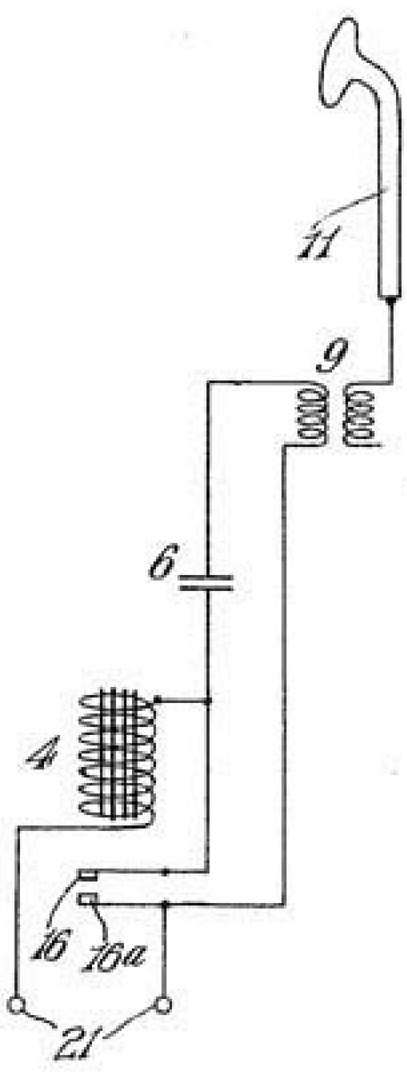

Fig. 2.

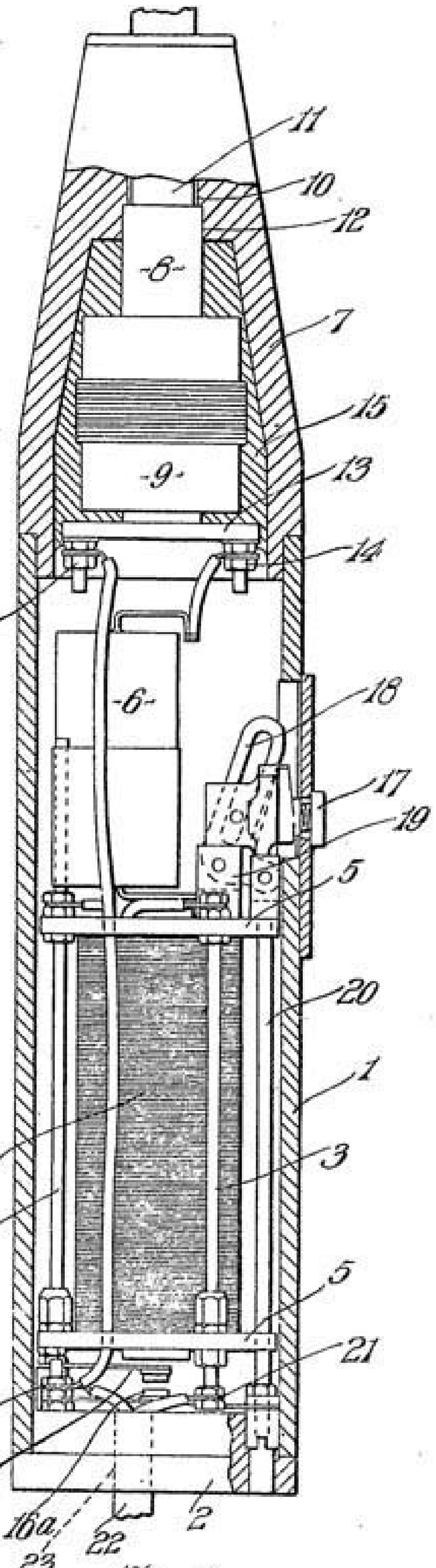

Fig. 1.

Malby & Sons, Photo-Litho.

some insulating material and are all joined firmly together and may be withdrawn from the box as a whole.

The kicking coil is mounted on one of the partitions together with the switch or contact breaker which may be of the usual vibrating spring type, commonly used in induction coils but having heavy silver contacts instead of platinum. The adjusting screw of the contact breaker is prolonged through the inner cover or plate and is provided with a handle of insulating material. This screw is arranged so that it cannot be screwed in so far as to prevent the contact-breaker working. The kicking coil has one or more tappings brought out from its winding and connected to plug sockets to allow of the apparatus being used on different supply pressures.

In addition to the ordinary winding the kicking coil has one or more secondary windings of comparatively few turns of coarse wire, the ends of these secondary windings being connected to suitable terminals on the inner cover.

Both the kicking coil and vibrating contact breaker are located in one of the end compartments referred to above. The middle compartment is occupied by the condenser while on the inner cover above this compartment is mounted a hand operated switch with several contacts arranged to switch the various coils "on" or "off."

In the third compartment the high frequency transformer is placed one end of the primary and secondary windings of the transformer are joined together and connected to a terminal on the inner cover, and the other end of the secondary is joined to a length of highly insulated flexible cable, which passes through a hole in the inner cover. At the other end of the flexible cable, a handle is provided made of ebonite or other suitable insulating material. The flexible cable passes merely through the said handle, and at a point near the outward end thereof, is connected to a brass socket or tube contained inside the end of the handle and adapted to take the various electrodes required to use the high frequency currents.

The handle may conveniently be made in three parts screwed together, first a bush or collar through which the flexible cable passes. Next a tube forming the handle proper. The brass socket is fitted inside the third portion which is hollow shaped like a truncated cone or nozzle having a cylindrical prolongation to its base, which fits into the tube portion. A radial hole through the cylindrical portion of the nozzle gives access to a screw fitted in the brass socket for the purpose of securing the flexible cable thereto.

This cylindrical portion is of sufficient length to enable the screw to be well down inside the tube portion of the handle so that leakage through the joints in the handle may be avoided.

In apparatus for production of high frequency currents operated by a kicking coil, an improvement is obtained by the use of a fixed (but adjustable) spark gap of the type known as a "quenched spark gap." This is connected in parallel with the ordinary contact breaker.

Dated this 15th day of April, 1921.

WHEATLEY & MACKENZIE,
40, Chancery Lane, London, W.C. 2,
Agents.

COMPLETE SPECIFICATION.

An Improved High Frequency Electrical Apparatus.

I, JOSEPH BERNARD BOWER, of 17, Church Lane, Merton Park, Wimbledon, London, S.W. 19, British subject, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention, for an improved high frequency electrical apparatus, has for its object to provide a portable and compact apparatus for use on ordinary commercial electric supplies of various pressures to enable currents of much higher frequency than those supplied by commercial electric generating stations, to be obtained; also to provide means for obtaining a second current of low pressure and more normal frequency suitable for heating a cautery instrument or other suitable element or for lighting a small lamp.

As is well known, these high frequency currents may be obtained in a circuit containing a properly proportioned inductance and capacity by allowing a charge contained in a condenser to be discharged across a spark gap, and through an inductance referred to below as the high frequency coil, the three being connected in series.

A known method of charging the condenser preparatory to this discharge entails the use of a coil known as a kicking coil, and which is in fact a coil wound on a core of iron wires or laminated stampings, so as to have a considerable inductance. The kicking coil is connected to a source of electricity through a switch arranged automatically to open and close the circuit rapidly. The condenser and high frequency coil are joined in series with one another and the remaining sides of the condenser and high frequency coil are connected one to each side of the switch which, when open, acts as the spark gap referred to above.

In order to utilise the high frequency current, it is usual to employ a secondary winding on the high frequency coil, this combination of high frequency coil and its secondary being known as a high frequency transformer.

According to this invention, the kicking coil, together with the switch or contact breaker associated therewith, also the condenser and the high frequency transformer are arranged in compartments formed in a box by vertical partitions secured to a horizontal top plate or inner cover which extends across a portion of the box and carries the terminals, hand switch, contact breaker adjuster and other adjuncts of the apparatus, the said partitions and top plate forming a readily removable support for the various parts of the apparatus, and when in position preferably leaving a free space for the reception of various accessories of the apparatus. A deeply recessed lid is hinged to the back of the box and covers the whole of the top and is provided with spring clips for holding electrodes or other adjuncts of the apparatus.

One practical form of the present invention is illustrated in the accompanying drawing in which:—

Fig. 1 is a front elevation of the complete apparatus with the front of the box removed.

Fig. 2 is a plan view of the same with the lid of the box removed, and

Fig. 3 is an end elevation of the electrical apparatus and partition walls removed from the box.

Fig. 4 is a diagram showing the connections.

Upon reference to these figures it will be seen that the main parts of the apparatus are arranged in three separate compartments formed in the box *a* by two parallel vertical partitions *b* and b^1 extending from a horizontal plate or inner cover portion *c* to the bottom of the box, and a third partition *d* extending along the box at right angles to the others, and dividing the compartmented space from a free space which is left in the box as aforesaid, but is not covered by the inner cover or plate *c*.

The working portion of the apparatus is attached to the various partitions *b*, b^1 and *d* and the inner cover or plate *c* which are of some insulating material and are all joined firmly together, and may be withdrawn from the box as a whole as shown in Fig. 3.

The kicking coil *e* is mounted on the partition b^1 together with the switch or contact breaker *f* which may be of the usual vibrating spring type, commonly used in induction coils but having heavy silver contacts instead of platinum. The adjusting screw f^1 of the contact breaker is prolonged through the inner cover or plate and is provided with a handle f^2 of insulating material. This screw is arranged so that it cannot be screwed in so far as to prevent the contact-breaker working. The kicking coil has one or more tappings brought out from its winding and connected to plug sockets *g* to allow of the apparatus being used on different supply pressures.

In addition to the ordinary winding the kicking coil has one or more secondary windings of comparatively few turns of coarse wire, the ends of these secondary windings being connected to suitable terminals *h* on the inner cover. By making connection to these terminals, a low pressure current is available for heating a cautery instrument or other element.

Both the kicking coil *e* and vibrating contact breaker *f* are located in one of the end compartments referred to above. The middle compartment is occupied by the condenser *i* while on the inner cover *c* above this compartment is mounted a hand operated switch *j* with contacts arranged to switch the various coils "on" or "off."

In the third compartment the high frequency transformer *k* is placed. One end of the primary winding and one end of the secondary winding of the transformer are joined together and connected to a terminal *l* on the inner cover, and the other end of the secondary is joined to a length of highly insulated flexible cable *m*, which passes through a hole in the inner cover. At the other end of the flexible cable, a handle *n* is provided made of ebonite or other suitable insulating material. The flexible cable passes nearly through the said handle, and at a point near the outward end thereof, is connected to a brass socket or tube contained inside the end of the handle and adapted to take the various electrodes (not shown) required to use the high frequency currents.

The handle *n* may conveniently be made in three parts screwed together, first a bush or collar n^1 through which the flexible cable passes. Next a tube forming the handle proper. The brass socket is fitted inside the third portion n^2 which is hollow shaped like a truncated cone or nozzle having a cylindrical prolongation to its base, which fits into the tube portion. A radial hole through the cylindrical portion of the nozzle gives access to a screw fitted in the brass socket for the purpose of securing the flexible cable thereto.

This cylindrical portion is of sufficient length to enable the screw to be well down inside the tube portion of the handle so that leakage through the joints in the handle may be avoided.

In apparatus for production of high frequency currents operated by a kicking coil, an improvement is obtained by the use of a fixed (but adjustable) spark gap of the type known as a "quenched spark gap." This is connected in parallel with the ordinary contact breaker.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. A portable high frequency electrical apparatus comprising a kicking coil, switch or contact breaker, condenser and high frequency transformer arranged in compartments formed in a box by partitions secured to an inner cover carrying the terminals, hand switch, contact breaker adjuster and other adjuncts of the apparatus, and forming a readily removable support for the different parts of the apparatus.

2. A portable high frequency electrical apparatus according to Claim 1, including the provision of a secondary winding or windings on the kicking coil connected with suitable terminals on the inner cover for obtaining a low pressure current suitable for heating a cautery instrument or other element.

3. In a portable high frequency electrical apparatus according to Claim 1, the use of a spark gap of the type known as a quenched spark gap in parallel with the ordinary contact breaker.

4. The improved high frequency electrical apparatus substantially as described with reference to the drawings.

Dated this 16th day of January, 1922.

WHEATLEY & MACKENZIE,
40, Chancery Lane, London, W.C. 2,
Agents.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1922.

[This Drawing is a reproduction of the Original on a reduced scale]

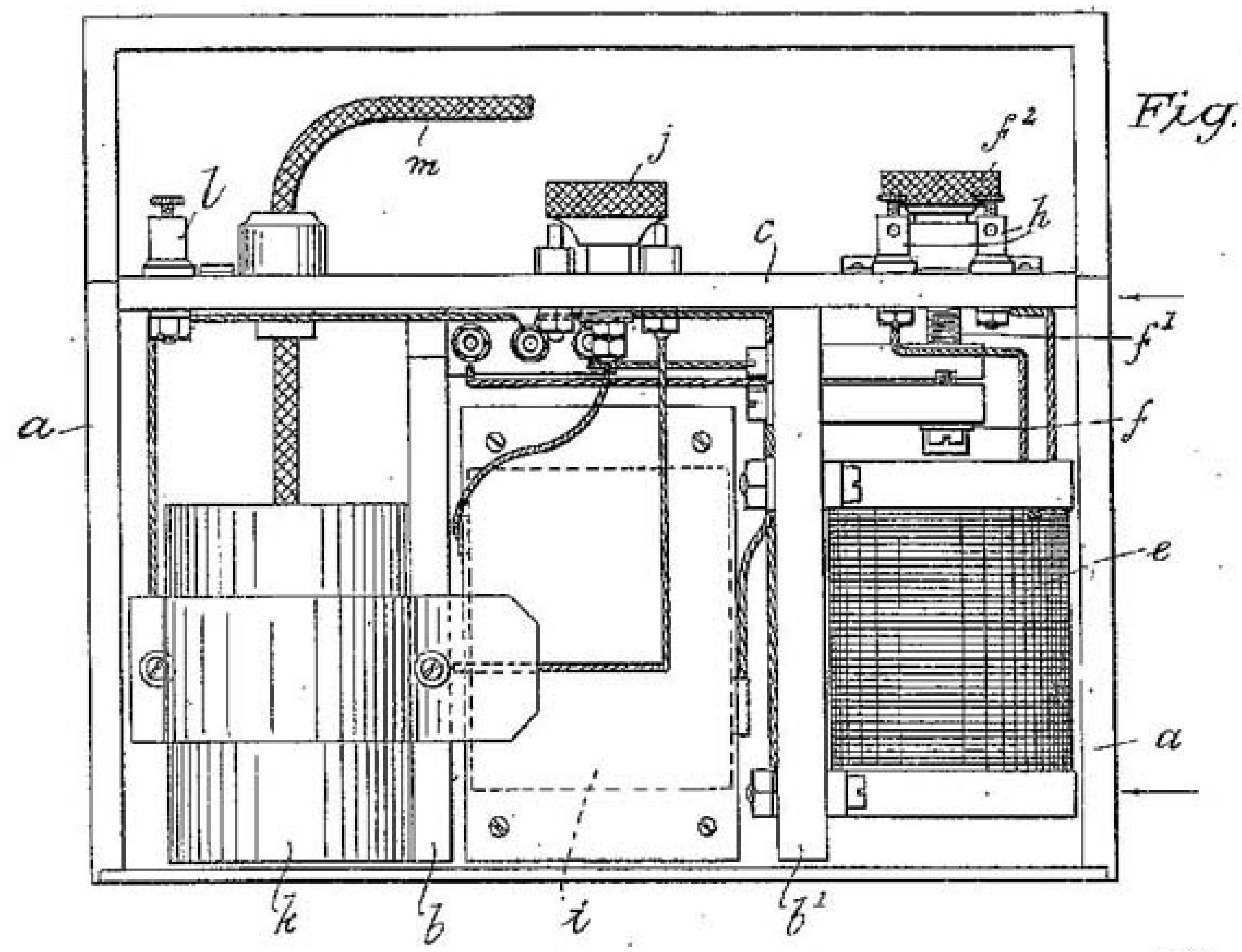

Fig. 1.

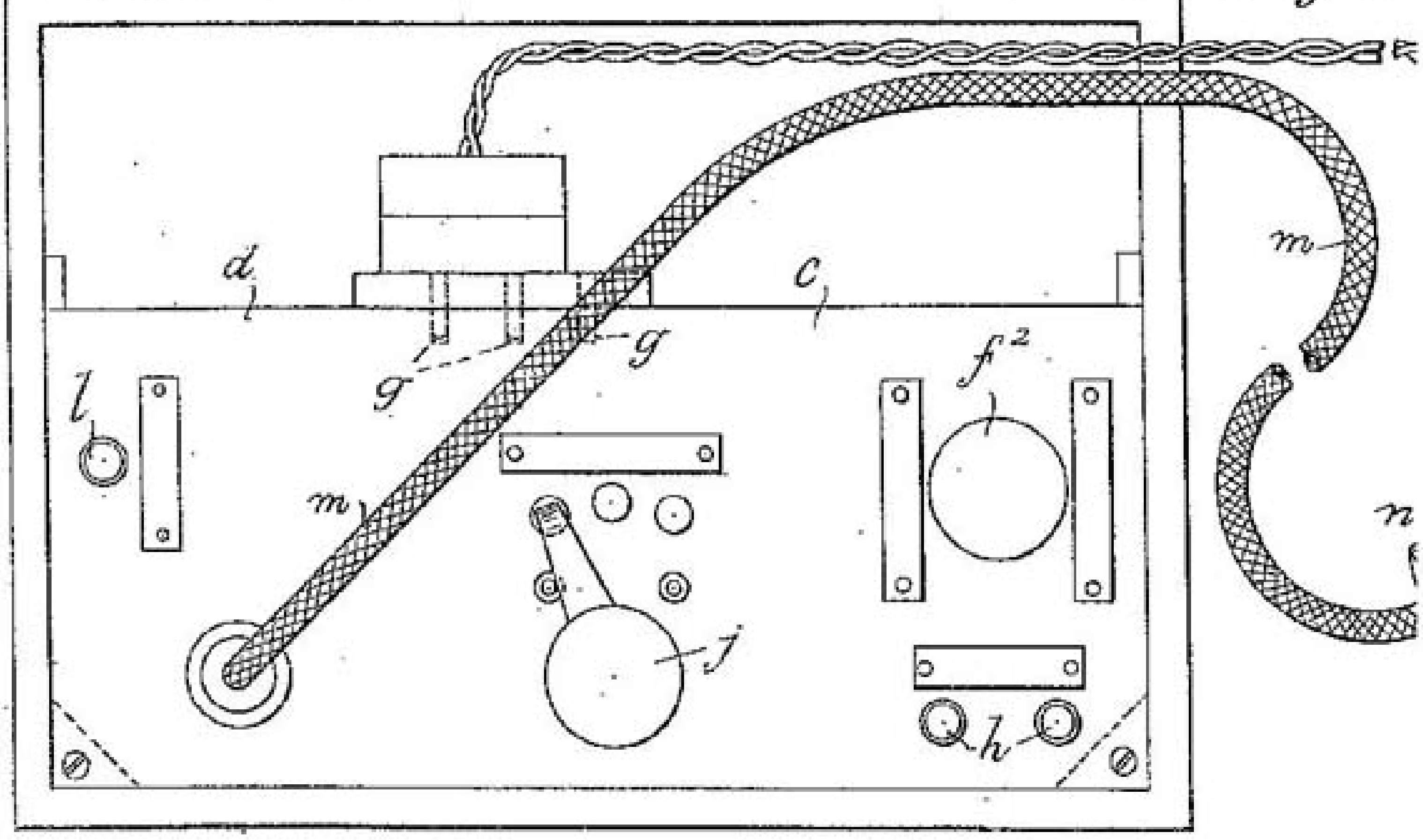

Fig. 2.

2 SHEETS
SHEET 1

Fig. 1.

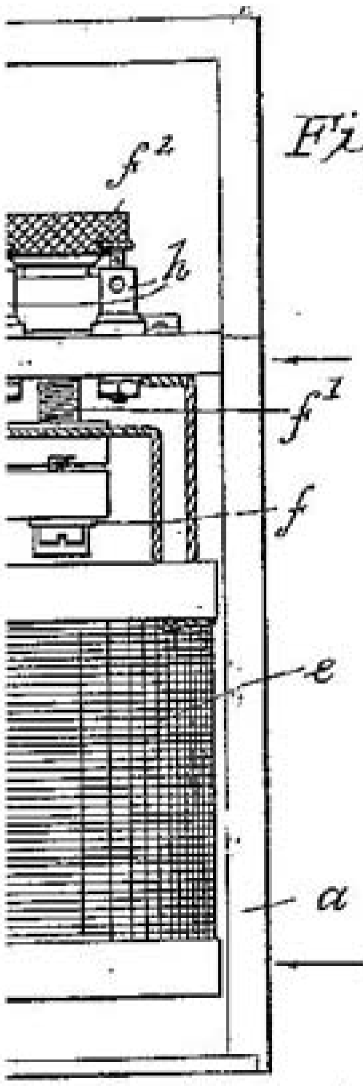

Fig. 3.

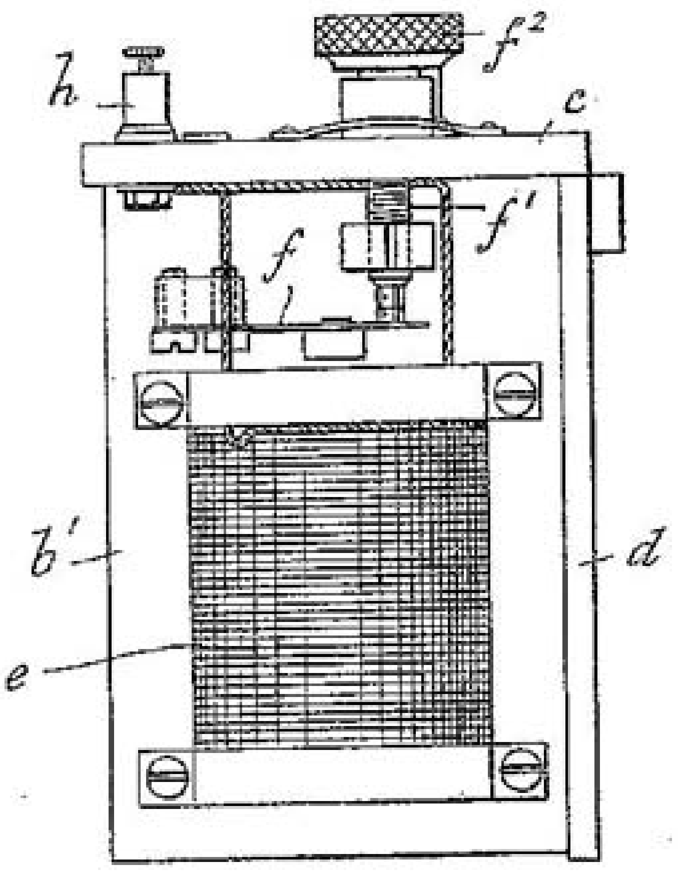

Fig. 2.

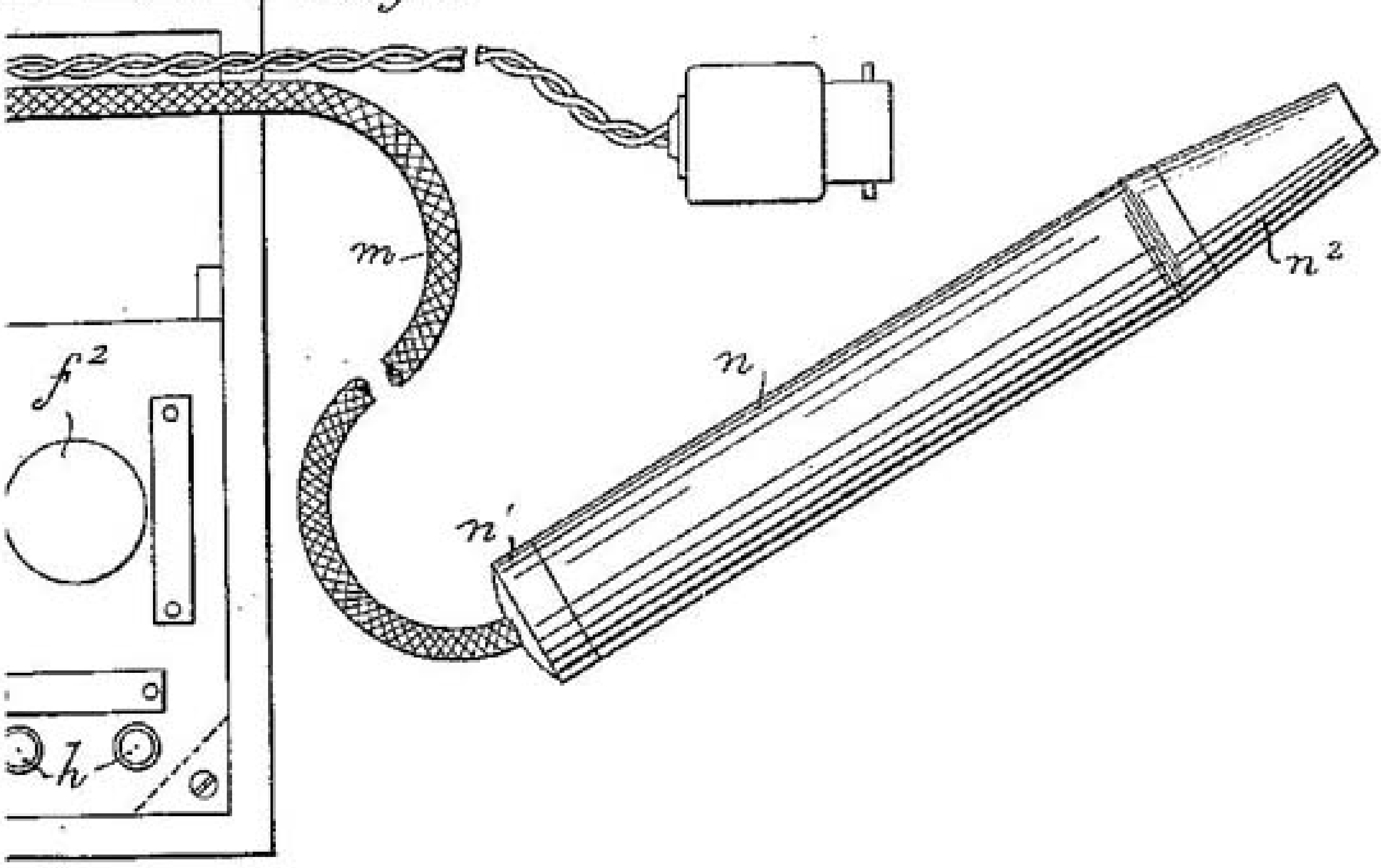

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Fig. 1.

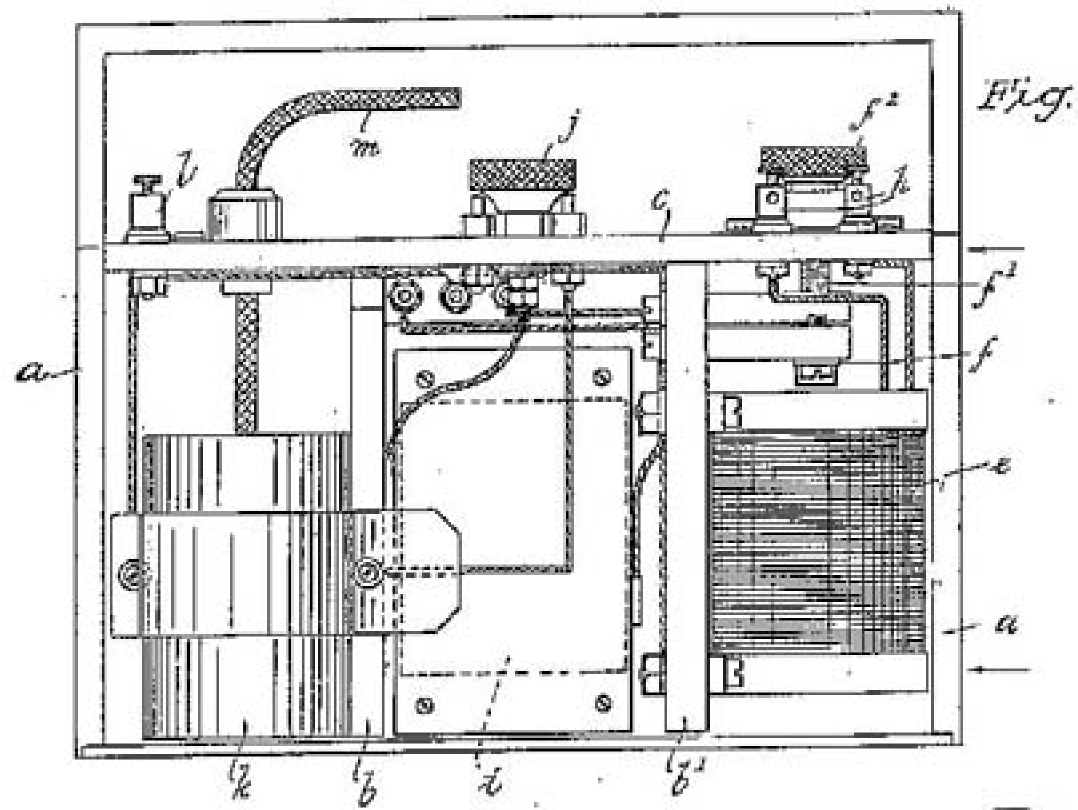


Fig. 3.

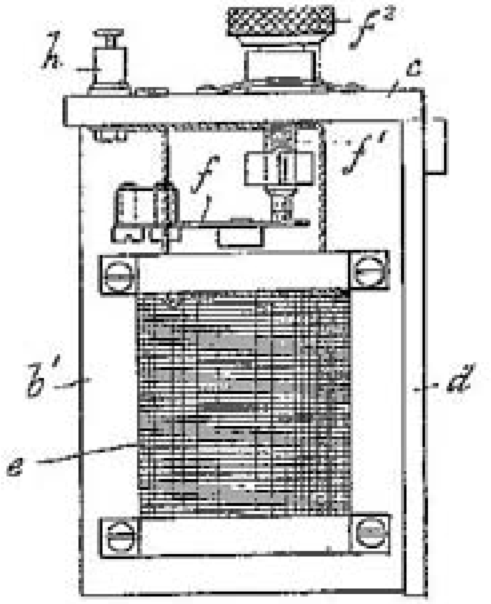
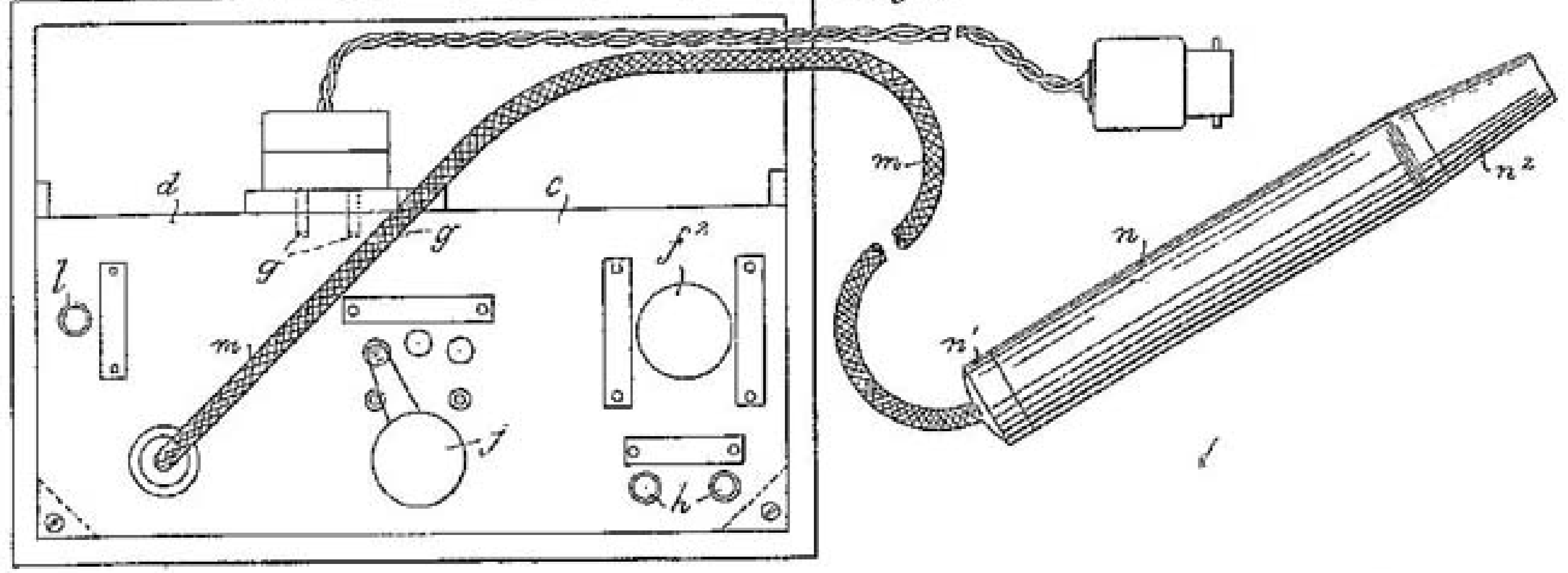


Fig. 2.

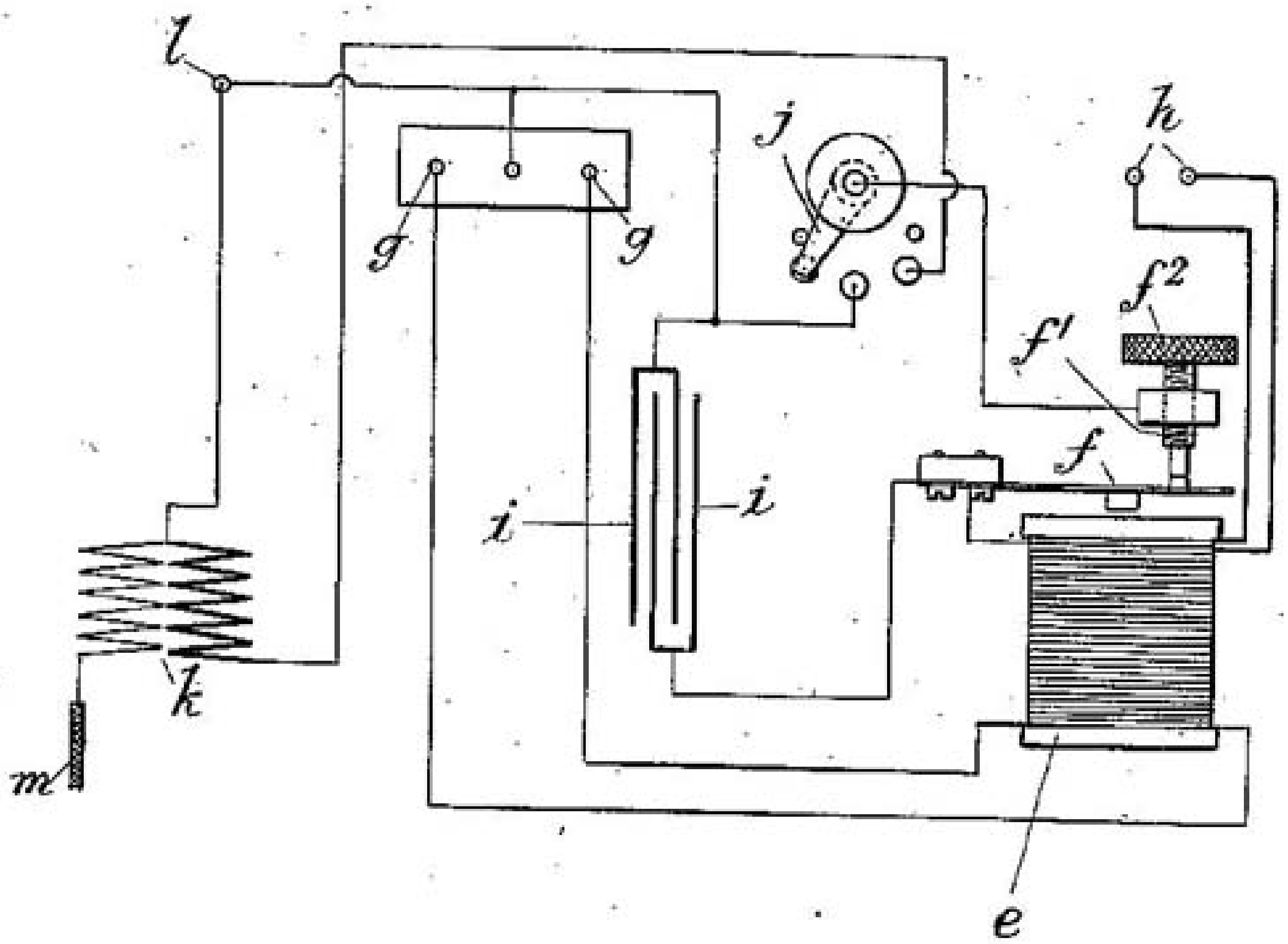


[This Drawing is a reproduction of the Original on a reduced scale]

Malby & Sons, Photo-Litho

[This Drawing is a reproduction of the Original on a reduced scale]

Fig. 4.



Malby & Sons, Photo-Litho

[Second Edition.]

PATENT SPECIFICATION

Application Date: Oct. 14, 1924. *No. 24,360/24.* 247,623

Complete Left: Aug. 14, 1925.

Complete Accepted: Feb. 15, 1926.

PROVISIONAL SPECIFICATION.

Improvements in High Frequency Electric Discharge Tubes and Generators, for Medical Purposes.

I, EUGENE VICTOR HAYES-GRATZE, Electrical and Consulting Engineer, a subject of the King of Great Britain, of 1, Gledhow Gardens, South Kensington, London, S.W. 5, do hereby declare the nature of this invention to be as follows:—

My invention relates to improvements in tubes and electrodes and generators for high frequency electric discharges and refers particularly to apparatus commonly and erroneously known as violet ray sets.

In general practice such sets comprise a kicking or impulse coil, a condenser and an oscillator suitably connected and arranged so that the high frequency discharge from the secondary winding of the oscillator is taken through an exhausted tube—commonly called an electrode—the connection usually being made to an external electrode placed at one end only of the tube.

Hitherto it has been universal practice to use tubes from which the air has been exhausted the result being that the life of same is very limited and they soon become hard, i.e. the vacuum increases thereby causing the internal resistance to rise and conductivity to the discharge decrease. Even when new these tubes require a considerable discharge to give the required results and this fact alone not only entails larger coils and current consumption than would otherwise be the case but tends to harden the tubes.

Another drawback is that the apparatus is bulky; it has to be made in separate units with flexible connections and entails considerable expense in manufacture.

My invention obviates these drawbacks, saves cost in production, requires less intensity of discharge and may be made more compact by combining the units.

[*Price* 1*s*.]

In carrying my invention into practice I add to the life and conductivity of the tubes by filling same with suitable gases such as neon, krypton, helium, argon, nitrogen, carbon dioxide, iodine or any combination of these; also I may use or charge them with any known metallic vapour either alone or combined with other gases, and of any desired pressure.

I am aware that gas fillings have been used with vacuum tubes or lamps used for illuminating or advertising purposes, but the present invention is confined solely to tubes used with the aforesaid sets to be used for medical and therapeutic purposes and operated through the medium of one internal or external electrode conducting currents or discharges of extremely high frequency from Tesla, Oudin or similar oscillators.

Having provided the tube of required shape or design and filled same with a suitable gas after exhaustion I may attach or connect same directly to the secondary of the oscillator winding and may also combine or arrange the kicking coil and condenser in the same container or case.

Alternatively I sometimes construct the tube so that the oscillator is combined with or forms an integral part of same, either by assembling the oscillator secondary inside the tube and the primary outside, or both may be inside or outside; with the condenser adjacent or separately assembled with the coil and contact breaker.

I may earth one end of the oscillator secondary or not according to the form of tube to be used and the treatment for which it has to operate.

The usual method of adjusting the intensity of discharge is to alter the tension or distance between the "make" and

Price 25p

"break" contacts; but I may leave this fixed and obtain the same or even better adjustment by employing a variable condenser or inductance in the circuit; or as an alternative I may employ a variable resistance; this may form part of the kicking coil winding and the required adjustment be obtained by varying the amount of iron core within the inductive circuit. It will therefore be seen that it is possible to construct the apparatus to be universal and suitable for working on supply circuits having voltages of 60 to 240.

When the units are assembled together the case or container may form the handle for the tube and by connecting the condenser near to the oscillator I save losses due to induction, capacity or radiation as is the case when long connections are used.

Dated this 16th day of July, 1924.

E. V. HAYES-GRATZE.

COMPLETE SPECIFICATION.

Improvements in High Frequency Electric Discharge Tubes and Generators for Medical Purposes.

I, Eugene Victor Hayes-Gratze, a subject of the King of Great Britain, of 1, Gledhow Gardens, South Kensington, London, S.W. 5, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to improvements in apparatus for generating high frequency electric discharges and refers particularly to apparatus commonly and erroneously known as violet ray sets.

In such apparatus it is usual to employ a kicking or impulse coil, an oscillator or transformer, a condenser in circuit with the kicking coil and in series with the primary winding of the transformer, an interrupter in circuit with the primary winding of the transformer and with the condenser, means for adjusting the intensity of the discharge and an electrode coupled in the oscillatory secondary circuit. The various parts have sometimes been contained within a casing serving as a handle for the electrode and the objects of the present invention are to provide in such self contained apparatus simple means for adjusting the intensity of the discharge, to make a more compact and better looking apparatus than hitherto and to provide a means for lengthening the life and conductivity of the discharge tube or electrode.

The present invention comprises in an apparatus of the kind described, means for adjusting the intensity of the discharge either by varying the amount of iron core within the inductive circuit or by the employment of a variable condenser, or by both these means, and may comprise the use of a discharge tube or electrode filled with a suitable gas, such as neon, krypton, helium, argon, nitrogen, carbon dioxide, iodine vapour or any combination of these and the formation of the primary and secondary windings of the oscillator on or within the discharge tube or electrode.

This invention will be now more particularly described making reference to the accompanying drawing in which:—

Fig. 1 is a view in side elevation—partly in section—and more or less diagrammatic of one embodiment of this invention and

Fig. 2 is a view in transverse section of the variable condenser.

Within a suitable casing *a*, preferably of cylindrical form or formed as a handle to the electrode *g*, and formed from vulcanite or other suitable material is carried a bobbin *b* on which is wound the kicking coil b^1. This coil is provided with a movable or sliding core b^2 making contact with a fixed pole piece b^3. Adjacent to the pole piece b^3 and attracted by it is mounted an interrupter, which may comprise the usual trembler blade *d* with a contact screw d^1. The core b^2 is adjusted or slid in or out of the bobbin *b* by an arm b^4 operated by a knob b^5 exterior to the casing *a*. Also mounted within the casing *a* is a condenser *e* and an oscillator or transformer *f*, which is connected in circuit with said condenser *e* as shown. One end of the secondary winding f^1 may be earthed to the main wire as shown and the other or high tension end is connected directly or indirectly with the electrode of the discharge tube *g*. This tube *g* is removably fixed in the one end of the casing *a*, the other end of which is provided with sockets or terminals a^1 adapting the device to be connected up to a suitable source of electric energy. The tube *g* beside being gas filled as before described, may be provided at its end opposite to that in connection with the secondary winding f^1 with a metallic deposit or sublimate g^1.

When the necessary adjustment is made by the condenser e or by the condenser in combination with the sliding core b^2, the variable condenser may take the form shown in Fig. 2 in which e^1 designates the fixed vanes or pole and e^2 the movable vanes or pole which are operated by the knob e^3 exterior to the case so as to cause the moving vanes e^2 to overlap the fixed ones e^1.

The necessary connections between the various parts are clearly shown on the drawing and do not require to be specifically referred to. A switch may be embodied in or on the casing.

The core b^2 may be automatically moved or controlled by the magnetic pull due to difference in load or consumption of current of the oscillator.

In a further modification, the tube may be combined with or form an integral part of the oscillator either by assembling the oscillator secondary inside the tube and the primary outside, or both may be inside or outside. The one end of the oscillator secondary may be earthed or not according to the form of tube to be used and the treatment for which it is designed.

The usual method of adjusting the intensity of discharge is by adjusting the interrupter so as to alter the tension or distance between the "make" and "break" contacts; adjustment has also been obtained by variation of the number of turns of the kicking coil in the circuit but according to the present invention the same result or even better adjustment is obtained by employing the variable condenser e or alternatively the required adjustment may be obtained by varying the amount of iron core within the inductive circuit as previously described or these means may be employed in combination. It will therefore be seen that it is possible to so construct the apparatus as to be suitable for working on supply circuits having pressures of from 60 to 240 volts.

The units are assembled together within the casing or container preferably so that the condenser is situated adjacent to the oscillator as shown in order to save losses due to induction, capacity or radiation as is the case when long connections are used.

It is already known to employ gas filled vacuum tubes or lamps for illuminating or advertising purposes and no claim is made to such tubes. The present improvement relating to discharge tubes is confined solely to tubes or electrodes used with electric discharge apparatus for medical and therapeutic purposes.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. A portable self contained high frequency electric discharge apparatus for medical, therapeutic and like purposes of the kind described, characterized in that the intensity of the discharge is adjusted either by varying the amount of iron core within the inductive circuit, or by the employment of a variable condenser, or by both these means in combination.

2. In a portable self contained high frequency electric discharge apparatus for medical, therapeutic and like purposes as claimed in Claim 1, forming the primary and secondary windings of the oscillator on or within the discharge tube or electrode.

3. In a portable self contained high frequency electric discharge apparatus for medical, therapeutic and like purposes as claimed in Claim 1, the provision of a discharge tube or electrode filled with neon, krypton, or like suitable gas as and for the purposes set forth.

4. The improved portable self contained high frequency electric discharge apparatus for medical, therapeutic and like purposes constructed and arranged substantially as hereinbefore described and as illustrated in the accompanying drawing.

Dated this 14th day of August, 1925.

A. MILLWARD FLACK,
Chartered Patent Agent,
Imperial Buildings, Ludgate Circus,
London, E.C. 4,
Agent for the Applicant.

Hereford: Printed for His Majesty's Stationery Office, by The Hereford Times Ltd.
[Wt. 67a—50/12/1927.]

247,623 COMPLETE SPECIFICATION **1 SHEET**

2nd Edition

[This Drawing is a reproduction of the Original on a reduced scale]

Fig.1.

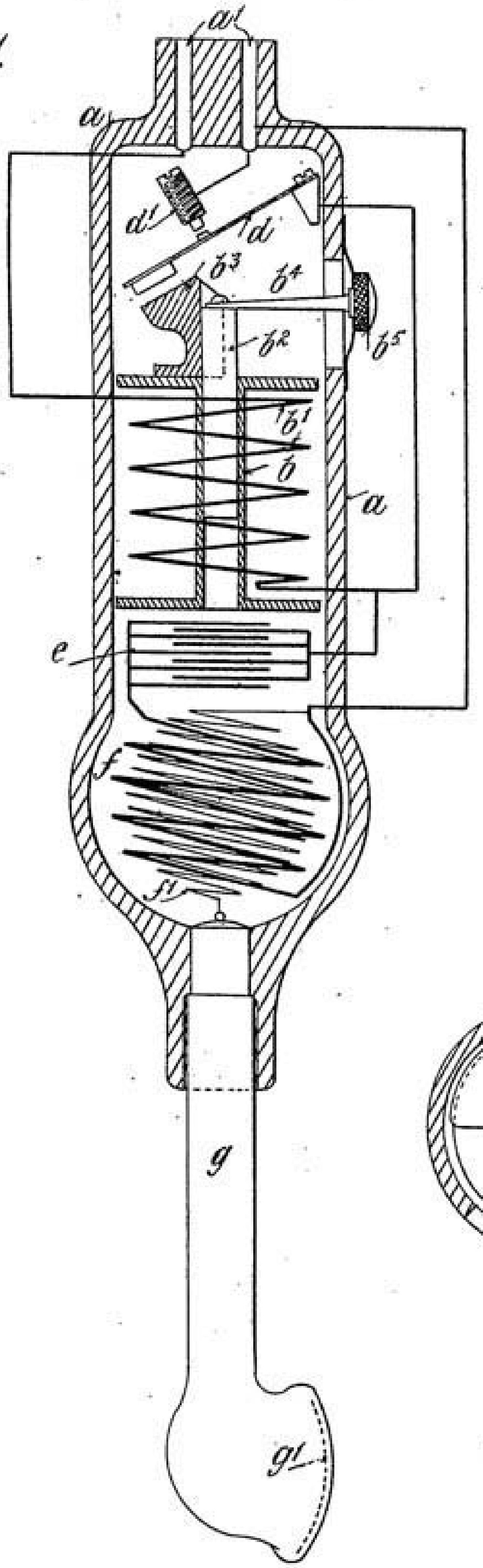
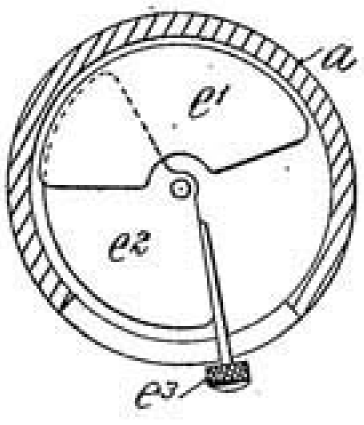


Fig.2.



Charles & Read Ltd. Photo Litho

PATENT SPECIFICATION

Application Date: April 27, 1926. No. 11,069/26.

271,620

Complete Left: Jan. 26, 1927.

Complete Accepted: June 2, 1927.

PROVISIONAL SPECIFICATION.

Improvements in or relating to Violet Ray High Frequency Apparatus.

I, George Herbert Leslie Beagley, of 2, Bedale Street, London Bridge, London, S.E. 1, a British subject, do hereby declare the nature of this invention to be as follows:—

This invention relates to high frequency apparatus for the production of violet rays for human treatment and has for its object to provide improved means whereby the strength of the rays produced may be regulated very simply.

Heretofore this regulation has been effected, as a rule, by rotating a knob on the screw serving to control the frequency of the trembler blade of the induction coil of the apparatus, the strength of the rays produced being dependent upon the frequency of the trembler.

According to the present invention, however, the adjusting screw of the trembler blade has fast thereon a dial bearing indications near its periphery and is provided with a handle which projects through an arcuate slot in the usual panel of the apparatus, said panel being formed also with an aperture or window through which may be read the indications on the dial; the arrangement being such that as the dial is rotated so the pressure with which the adjusting screw bears against, and hence the frequency of, the trembler blade is varied.

The dial is preferably of comparatively large diameter so that minute adjustments of the frequency of the blade may the more readily be carried out; the aperture or window in the panel in conjunction with the indications on the dial serving to enable the adjustment of the device to be set to any desired or predetermined value.

The angular movement of the dial is limited to substantially one hundred and eighty degrees by the engagement of the dial handle with the ends of the slot which thus serve as stops for preventing too great movement of the dial.

Apparatus with adjusting means in accordance with the present invention is especially adapted for use by unskilled persons, because the strength of the rays produced is indicated directly by the indications (which may take the form of words such as "off", "weak", "medium", "strong", "full" and the like) on the dial and because of the ease with which very small changes in the strength of the rays may be effected.

Dated the 27th day of April, 1926.

A. M. & WM. CLARK,
Chartered Patent Agents,
53 & 54, Chancery Lane, London,
W.C. 2.

COMPLETE SPECIFICATION.

Improvements in or relating to Violet Ray High Frequency Apparatus.

I, George Herbert Leslie Beagley, of 2, Bedale Street, London Bridge, London, S.E. 1, a British subject, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to high frequency apparatus for the production of violet rays for human treatment and has for its object to provide improved means

[Price 1/-]

whereby the strength of the rays produced may be regulated very simply.

Heretofore this regulation has been effected, as a rule, by rotating a knob on the screw serving to control the frequency of the trembler blade of the induction coil of the apparatus, the strength of the rays produced being dependent upon the frequency of the trembler.

According to the present invention, however, the adjusting screw of the trembler blade has fast thereon a dial bearing indications near its periphery and is provided with a handle which projects through an arcuate slot in the usual panel of the apparatus, said panel being formed also with an aperture or window through which may be read, one only at a time, the indications on the dial; the arrangement being such that as the dial is rotated so the pressure with which the adjusting screw bears against, and hence the frequency of, the trembler blade is varied.

The dial is preferably of comparatively large diameter so that minute adjustments of the frequency of the blade may the more readily be carried out; the aperture or window in the panel in conjunction with the indications on the dial serving to enable the adjustment of the device to be set to any desired or predetermined value.

The angular movement of the dial is limited to substantially one hundred and eighty degrees by the engagement of the dial handle with the ends of the slot which thus serve as stops for preventing too great movement of the dial.

One form of the invention is illustrated in the accompanying drawings of which Figure 1 is a plan view, and Figure 2 is a fragmentary view shewing the insulating panel of the apparatus in sectional elevation on the line 2—2 of Figure 1.

As shown, instead of the usual knob, the adjusting screw *a* of the trembler blade, indicated in section at *b*, Figure 2, has fast thereon a dial *c*, to which latter is attached as at *d* a handle *e*. The usual insulating panel *f* of the device is formed with an arcuate slot *g* to give passage to the mounting of the handle *e* (see Figure 2), and also with an aperture *h* which preferably is glazed as at *j*, a suitably shaped piece of glass or celluloid *j* being retained in position by a rebated metal ring *k* bolted to the panel *f* as shewn in Figure 2. There are provided on the dial *c* near its periphery a series of indications, such as "FULL—5—4—3—2—1—WEAK—OFF" as shewn in Figure 1; the relative positions of the dial *c*, the arcuate slot *g* and the aperture *h* being chosen so that, as the dial *c* is rotated by means of the handle *e*, the indications are caused one after another to appear to view through the aperture *h* and so to indicate the relative strengths of the rays produced at the different settings or angular positions of the dial *c*.

Apparatus with adjusting means in accordance with the present invention is especially adapted for use by unskilled persons, because the strength of the rays produced is indicated directly by the indications on the dial and because of the ease with which very small changes in the strength of the rays may be effected.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. Apparatus for the production of violet rays for human treatment, wherein there is mounted fast upon the adjusting screw, serving to control the frequency of the trembler blade of the induction coil of the apparatus, a dial bearing indications near its peripheral margin and provided with a handle which projects through an arcuate slot formed in the usual panel of the apparatus, said panel being formed also with an aperture or window through which may be read, one only at a time, the indications on the dial; the arrangement being such that as the dial is rotated so the pressure with which the adjusting screw bears against, and hence the frequency of, the trembler blade is varied.

2. Apparatus for the production of violet rays for human treatment, as claimed in Claim 1, wherein the dial is of comparatively large diameter so that minute adjustments of the frequency of the trembler blade may the more readily be carried out, and wherein the angular movement of the dial is limited to substantially one hundred and eighty degrees by the engagement of the dial handle with the ends of the arcuate slot which thus serve as stops for preventing too great movement of the dial.

3. Apparatus for the production of violet rays for human treatment, having adjusting means, constructed, arranged, and adapted to be employed substantially as hereinbefore set forth with reference to the accompanying drawings.

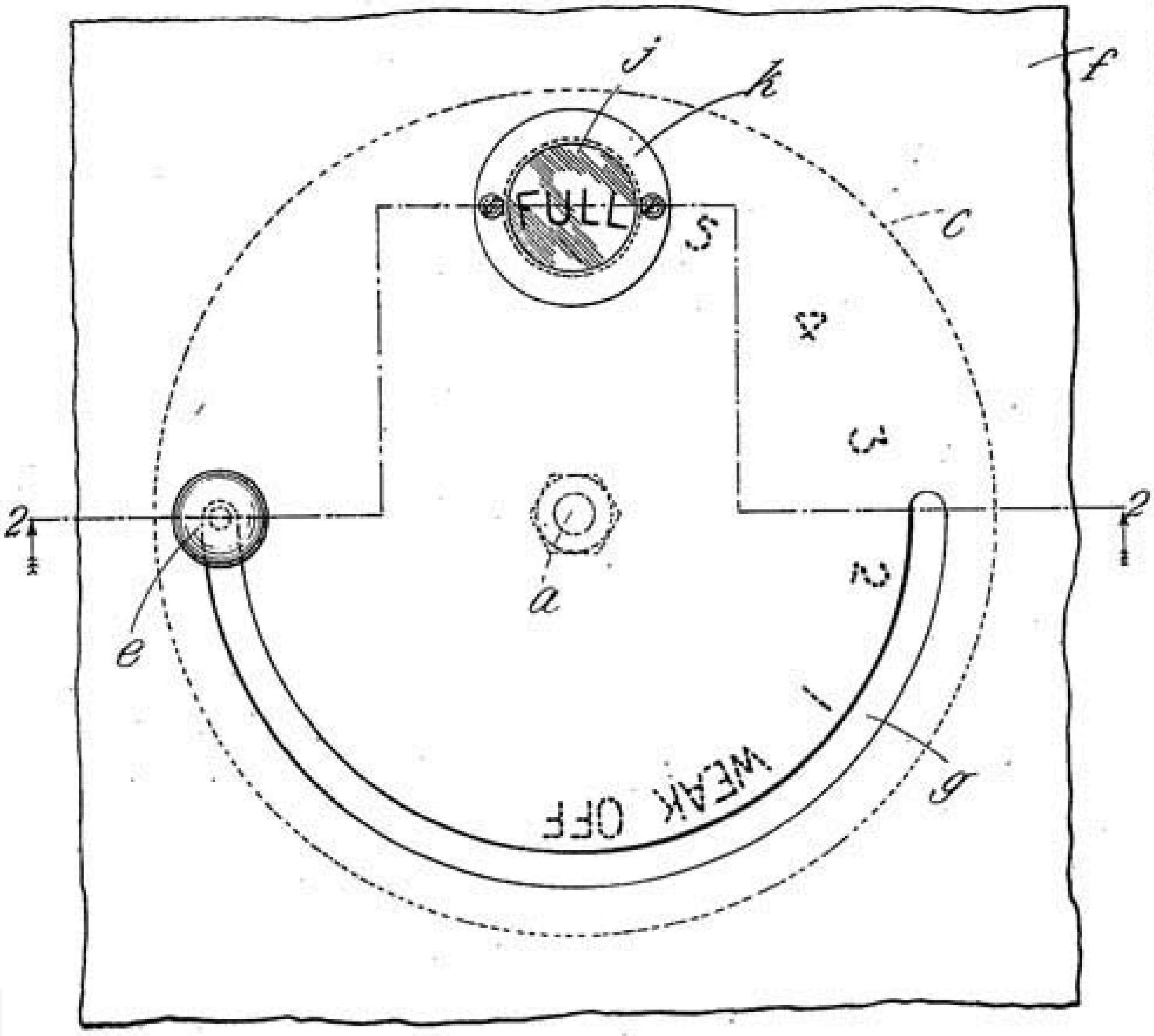
Dated the 26th day of January, 1927.

A. M. & WM. CLARK,
Chartered Patent Agents,
53 & 54, Chancery Lane, London,
W.C. 2,

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1927.

[This Drawing is a reproduction of the Original on a reduced scale]

Fig. 1.



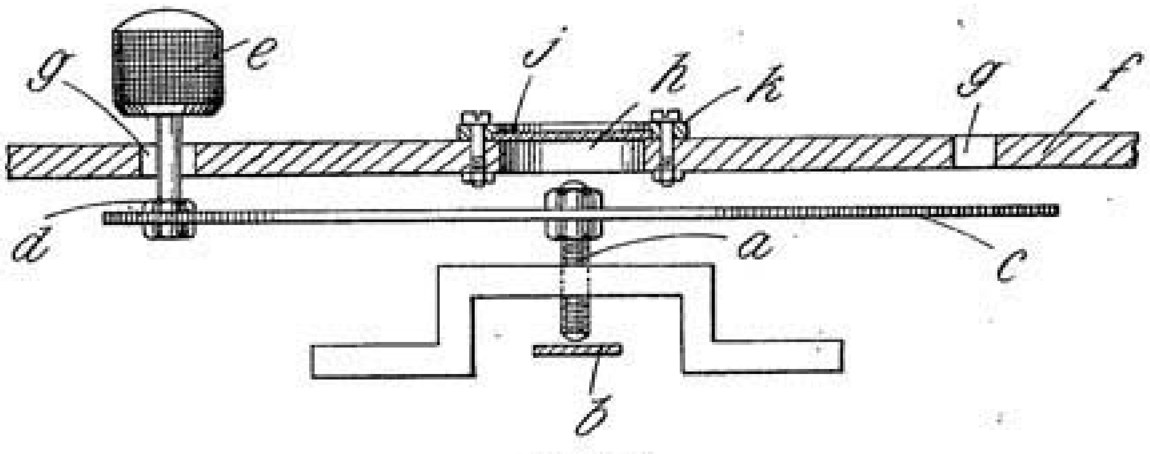


Fig. 2.

Charles & Read Ltd. Photo Litho.

PATENT SPECIFICATION

Application Date: April 22, 1927. No. 10,811/27.

294,283

Complete Left: Jan. 21, 1928.

Complete Accepted: July 23, 1928.

PROVISIONAL SPECIFICATION.

Improvements in Electro-therapeutic Apparatus.

I, Joseph Harrison Thomson Roberts, 73, Wentworth Road, Golders Green, London, N.W. 11, British, do hereby declare the nature of this invention to be as follows:—

This invention has reference to electrical apparatus, more particularly of the kind which is used for the electrical treatment of the hair, and has for its object to provide certain simple and inexpensive means whereby such treatment can be effected.

In one form of the invention a comb may be made of metal or other sufficiently conducting substance, which comb may be adapted by means of a suitable projection to fit into the socket of high-frequency (so called violet ray) apparatus in the place of any of the usual exhausted glass tube electrodes. As the strength of the current in this case would be liable to be excessive, and furthermore in order to produce an optical effect, I may use a glass tube electrode to which the comb is attached; for example, the comb may be provided with clips which enable it to slip upon the glass tube electrode.

In another form of the invention a comb may be fitted to a hand-electrical-generating appliance similar to the small dynamo-electric generators which are sometimes used in hand flashlamps. These generators are of the type which have a projecting lever or other member which is continually depressed by the hand and released and by this action (and the use of suitable ratchets, etc., within the mechanism) a small electrical generator is kept in rotation or otherwise operated so as to produce electric current. The current so generated may be produced either at a low voltage or at a comparatively high voltage—as in the magneto-electric devices which are sometimes employed for electro-medical work: the current in these magneto devices is usually alternating current which is developed at a voltage sufficiently high to pass an appreciable spark in air at atmospheric pressure. Condensers, inductances, transformers, and any of the usual devices for use in connection with a generating apparatus for producing a fairly high voltage may be employed. The actual current required in the present case is small, whilst the voltage required is fairly high and consequently a magneto electric device (or a tiny dynamo electric device together with step up auxiliary devices) is particularly appropriate for therapeutic treatment in the manner contemplated in the present invention.

With similar mechanism the actual electrical generating apparatus—instead of being of the dynamo-electric or magneto-electric type—may be of the type which generates so-called static electricity, on the principle of the old-fashioned electrical machines, such as induction and frictional machines. For example, two co-axial ebonite cylinders may be used, one of them rotating at a fairly high speed about its own axis. The electricity thus generated may be conveyed to the comb in the manner already set out above. Thus, in this form of the invention the essential feature is the provision of a hand-generating device or apparatus of the type mentioned above for producing what may be called dynamo-electric current, or magneto-electric current, or so called static or frictional electricity, the hand-generating device being adapted to be used in conjunction with and to be operated with suitable electrodes or applicators (including comb) for therapeutic massage or suchlike application of electricity. The generating apparatus may, of course, be separate from the electrode or applicator, and may be connected to the same by suitable flexible electrical connector. For example, the generator might be held in the left hand and operated by that hand, whilst the comb might be held in and used by the right hand, the comb being connected by means of a short length of flexible cable to the generator. Alternatively, the generator may be adapted to be placed upon the floor and the operating lever to be operated by means of the foot, connection again being made to the electrode or applicator by means of flexible cable. This form of the device is evidently adapted for use in a hair-dressing establishment where the electric

[*Price* 1/-]

treatment is administered by an operator other than the actual user.

It will be seen that various modifications and elaborations may be made without departing from the principle or spirit of the invention, and I do not limit myself as to the details of my invention but may modify or elaborate the same to suit requirements.

Dated this 22nd day of April, 1927.
JOSEPH H. T. ROBERTS.

COMPLETE SPECIFICATION.

Improvements in Electro-therapeutic Apparatus.

I, JOSEPH HARRISON THOMSON ROBERTS, British subject, of 73, Wentworth Road, Golders Green, London, N.W. 11, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to electro-therapeutic apparatus and has for its object to provide improved means for electro-therapeutically treating the hair in the act of combing and more particularly to enable the hair to be treated by the effect of high-frequency high-tension electric discharge as distinct from the relatively low tension usual in medical battery and similar appliances hitherto employed.

The comb according to the present invention comprises comb teeth of metal or other electric conducting material, and a discharge tube or similar electric resistance and condenser applicator device whereby high-frequency high-tension electric current is conveyed to the comb teeth. In the preferred construction these comb teeth are integral with or conductively attached to a body of metal or other electric conducting material attached to a so-called violet-ray applicator tube terminating in a metal cap or plug for insertion into the holder of a violet-ray applicator device.

The manner in which the invention may be carried into effect is illustrated by way of example in the accompanying drawings in which:—

Figure 1 is a view of the apparatus in its preferred form.

Figure 2 illustrates a self-contained combing appliance in accordance with the invention.

Referring first more particularly to Figure 1, the reference numeral 1 indicates a high-frequency high-tension electric generator and 2 indicates an "applicator" or electrode holder constituting parts of an ordinary violet-ray apparatus. The holder 2 is adapted to receive the metal plug or terminal 3 which is also a socket for the partially exhausted glass tube or electrode 4 to which is secured by metal clips or loops 5 the metal backing or rib of the metal teeth 6.

In the modification shown in Figure 2 the outfit is made self-contained, by combining a high-frequency high-tension generator with the applicator handle and providing on the combined unit 7 a press knob 8 or the like for repeated actuation by hand of the generator so long as electricity is required.

Although the invention has been particularly described with reference to certain structural embodiments, the invention is not to be regarded as limited thereto, as various structural modifications may be resorted to without departing from the spirit and scope of the invention. For example the electric generator within the unit 7 of Figure 2 might be located on the floor for pedal operation and be connected to the comb holder by a suitable flexible cable.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. An electro-therapeutic comb comprising comb teeth of metal or other electric conducting material, and a discharge tube or similar electric resistance and condenser applicator device whereby high-frequency high-tension electric current is conveyed to the comb teeth.

2. An electro-therapeutic comb as claimed in Claim 1, in which the comb teeth are integral with or conductively attached to a body of metal or other electric conducting material attached to a so-called violet-ray applicator tube terminating in a metal cap or plug for insertion into the holder of a violet-ray applicator device, substantially as described.

3. An electro-therapeutic combing outfit constructed, arranged and adapted to operate substantially as hereinbefore described with reference to the accompanying drawings.

Dated the 22nd day of January, 1928.
For J. H. T. ROBERTS,
White, Langner, Stevens & Parry,
Chartered Patent Agents,
Jessel Chambers,
88—90, Chancery Lane, London,
W.C. 2, and
17, John Street, New York, U.S.A.

[This Drawing is a reproduction of the Original on a reduced scale]

Fig. 1.

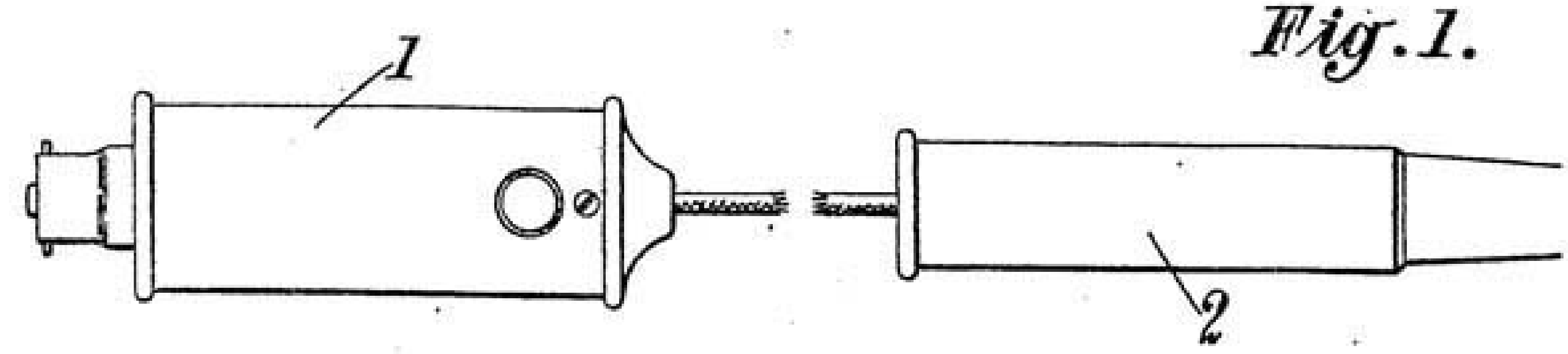
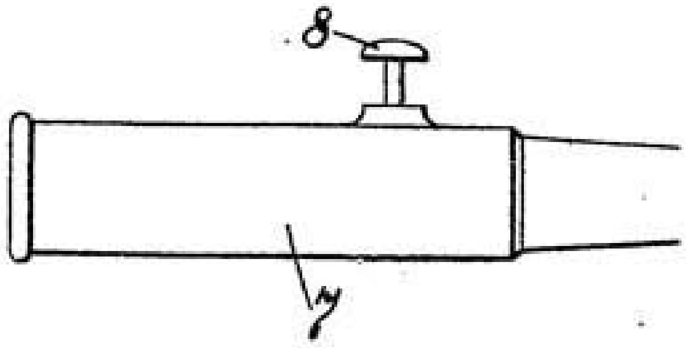
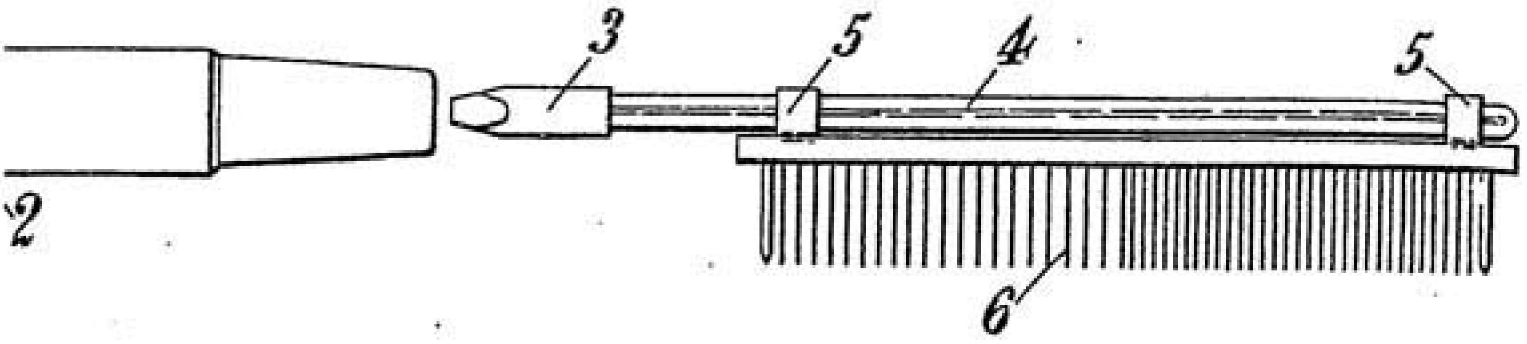


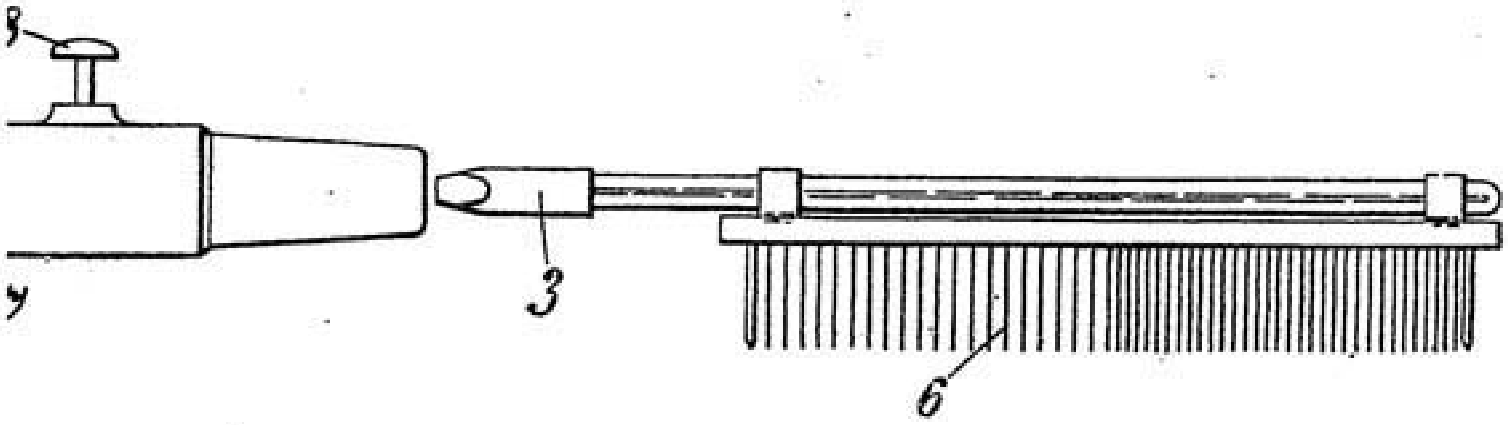
Fig. 2.



1 SHEET

Fig.1.





Charles & Read Ltd. Photo Litho.

Fig. 1.

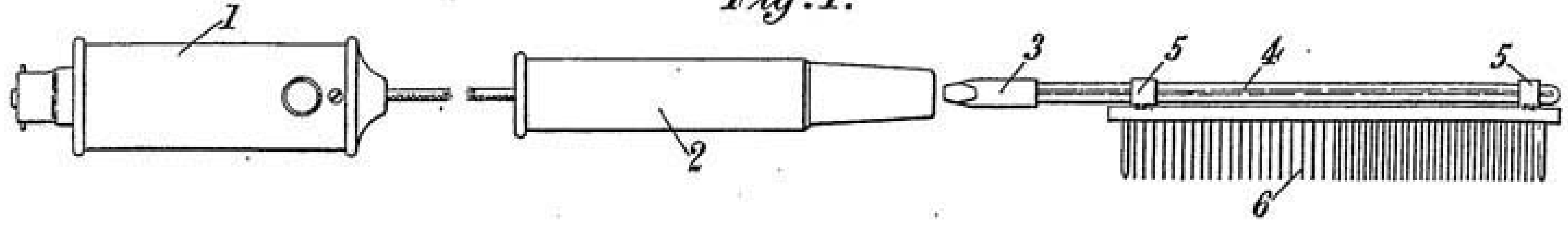
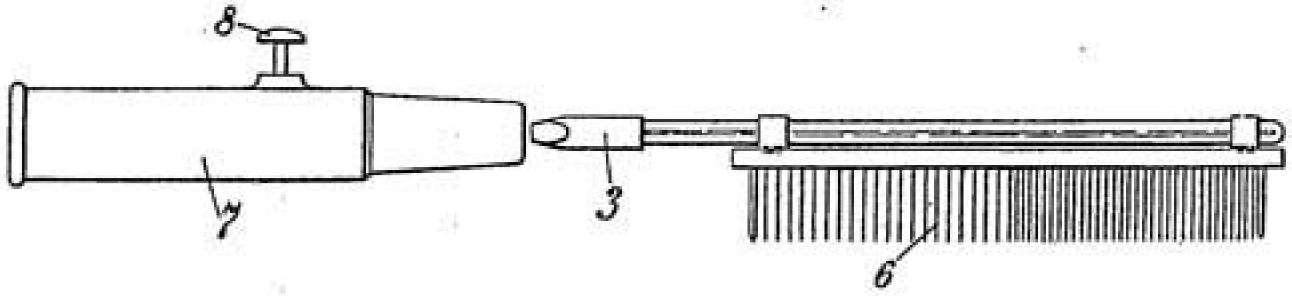


Fig. 2.



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Charles & Read Ltd. Photo Litho

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PATENT SPECIFICATION

Application Date: Oct. 15, 1937. No. 28152/37.

504,345

Complete Specification Left: Oct. 17, 1938.

Complete Specification Accepted: April 17, 1939.

PROVISIONAL SPECIFICATION

Improvements in Adjusting Devices for the Contacts of Electro-Magnetic Vibrators for High Frequency Electro-Medical Apparatus and the like

I, CHARLES ARCHELUS COOPER, a British Subject, of 25, Holborn Viaduct, London, E.C.1, do hereby declare the nature of this invention to be as follows:—

This invention relates to improvements in control devices for high frequency electro-medical apparatus and the like and has more particular reference to means for controlling vibrators used in "Violet-Ray" high frequency electric current apparatus.

In such devices it is necessary and particularly desirable that the operator be able to control with facility the strength or intensity of the treatment and that the current should only be switched on when the applicator has already been placed in contact with the patient's body, and then that it should be possible gradually to increase the output and furthermore that, prior to the withdrawal of the applicator, the operator can reduce the strength of the emanation or discharge and then, whilst the instrument is still in the same contact or proximity, cut off the energising current, otherwise there is a tendency for sparking to take place or a spasm created due to sudden stoppage and removal of the applicator.

The object of the invention is to provide a control of the vibratory interrupter in the energising circuit, whereby manipulation and control can be simultaneous operations and the device whilst application is taking place be employed gradually to lessen and then entirely arrest the treatment.

The invention consists of means to adjust the gap distance between the vibratory members of the induction coil and comprises a pivoted lever carrying one of said vibratory contacts so positioned and actuated from an external hand mobile button or slide that movement of the latter advances or retracts the one contact to the other.

In carrying the invention into effect and in the preferred manner, one of said vibratory contacts, and preferably the lowermost is mounted upon a spring, the latter being secured to a lever pivoted at a point beyond the contact pin and the end of said lever remote from said pivot is coupled to a movement multiplying lever or system of levers which in turn are actuated by the movement of the external slide button or stud; thus in operation the movement of the slide stud or button will produce a small movement of one of the vibratory contacts and such in practice may be of the order of 16—1 or thereabouts. As the distance between the said contacts lessens, the vibration and periodicity of the applied current increases and *vice versa*, giving the operator the ability to manipulate with varying strengths up to a point of cessation.

Dated this 15th day of October, 1937.

HERON ROGERS & CO.,
Agents for Applicant,
Bridge House, 181, Queen Victoria Street,
London, E.C.4.

COMPLETE SPECIFICATION

Improvements in Adjusting Devices for the Contacts of Electro-Magnetic Vibrators for High Frequency Electro-Medical Apparatus and the like

I, CHARLES ARCHELUS COOPER, a British Subject, of 25, Holborn Viaduct, London, E.C.1, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to improvements in control devices for high frequency electro-medical apparatus and the like and

[*Price* 1/-]

has more particular reference to means for controlling vibrators used in "Violet-Ray" high frequency electric current apparatus.

In such devices it is necessary and particularly desirable that the operator be able to control with facility the strength or intensity of the treatment and that the current should only be switched on when the applicator has already been placed in contact with the patient's body, and then that it should be possible gradually to increase the output and furthermore that, prior to the withdrawal of the applicator, the operator can reduce the strength of the emanation or discharge and then, whilst the instrument is still in the same contact or proximity, cut off the energising current, otherwise there is a tendency for sparking to take place or a spasm created due to sudden stoppage and removal of the applicator.

The present invention provides a particularly simple and effective mechanism for controlling the vibrator in such a way as to meet the above stated requirements.

The mechanism according to the invention comprises a button or other manually operable slidable member, a pivotal lever coupled to the button by a pin and slot or equivalent connection so that the sliding movement of the button is converted into a rocking movement of the lever and a further member by which the rocking movement of the lever is converted into a reciprocating movement which is reduced in amplitude as compared with the movement of the button, the movement of the last-mentioned member being employed for adjusting the vibratory contact device.

According to a subsidiary feature of the invention, the last-mentioned member consists of a slidable push rod coupled at one end to the aforesaid lever and at the other end to a springy plate carrying one of the contacts of the vibrator.

According to a further subsidiary feature of the invention an "off" position of the button is provided and the mechanism is arranged so that movement of the button in a forward direction from the "off" position first causes the contacts to touch so as to bring the induction coil into action and then reduces the length of the air gap between the vibrator and the core of the induction coil so as gradually to increase the strength of the discharge.

The invention will be more readily understood from the following description with reference to the accompanying drawing in which a "Violet-Ray" high frequency apparatus embodying adjusting mechanism constructed according to the invention is shown partly in section.

The apparatus shown in the drawing comprises a body 1 adapted to be held in the hand of the operator and equipped with a socket 2 into which the applicator, a portion of which is shown at 3, is inserted.

The body 1 contains an induction coil 4 equipped with a vibratory interruptor comprising a vibrator 5 adapted to be vibrated by the magnetic attraction of the core of the induction coil and a contact 6 which is adjustable towards and away from the vibrator 5 for the purpose of regulating the strength of the emanation or discharge produced. The vibrator 5 is carried on a springy plate 7. The contact 6 is carried on a springy plate 8, one end of which is secured to a fixed support as indicated at 9 whilst the other end engages an annular grooved sleeve 10*a* secured to a push rod 10 mounted to slide in suitable guides provided for it in the spool flanges of the induction coil 4 and in the base of the casing 1.

The push rod 10 is pivotally connected at its upper end to a bell crank lever 11 having a fixed fulcrum 12. One arm of the bell crank lever is slotted as shown at 11*a* and is adapted to be actuated by a sliding member 13 equipped with a pin 14 which engages in the slot 11*a*. The sliding member 13 is guided in a slot 15 formed in the casing 1 and is held in place by means of a screw 16 which passes through a plate 17 mounted to slide on the external surface of the casing 1 and engages in a tapped hole in the part 13.

The plate 17 can be pushed up and down by hand so as to cause the part 13 to slide in the slot 15. The movements of the part 13 impart a rocking movement to the bell crank lever through the medium of the pin 14 and this movement is transmitted through the push rod 10 to one end of the plate 8 so that the contact 6 is moved towards or away from the vibrator 5.

In the position of the parts shown in the drawing the hand control member 17 is at the extreme downward limit of its movement and the contact 6 is out of contact with the vibrator 5 so that the induction coil 4 is out of action.

If the manual control member 17 is pushed upwards the contacts 5 and 6 touch and close the circuit so that the induction coil 4 comes into action. Further upward movement reduces the length of the air gap between the core 4*a* and the vibrator 5 and gradually increases the intensity of the discharge owing to the greater tension placed on the springy plate 7. It will be seen that the strength of the discharge is at a maximum when the part 17 is at the upward limit of its movement. As the part 17 is moved downwards the strength of the discharge is gradually reduced. Further downward movement stops the discharge so that the extreme downward position of the part 17 constitutes an off position.

An important feature of the mechanism is that the pin 14 attached to the sliding control member and the slotted arm 11 of the bell crank lever are arranged so that the movement imparted to the push rod 10 and thence to the contact member 6 is greatly reduced as compared with the movement of the manual control member 17. This arrangement enables the operator to adjust the length of the air gap between the vibrator and the magnetic core with great accuracy and thereby facilitates fine adjustment of the strength of the discharge. The relative positions of the slotted arm of the lever 11 and the springy plate 8 carrying the contact 6 may be adjusted by screwing the grooved sleeve 10*a* up and down on the rod 10.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. A control device for high frequency electro-medical apparatus in which the exciting current is produced by means of an induction coil equipped with vibratory contact members comprising a button or other manually operable slidable member, a pivotal lever coupled to the button by a pin and slot or equivalent connection so that the sliding movement of the button is converted into a rocking movement of the lever and a further member by which the rocking movement of the lever is converted into a reciprocating movement which is reduced in amplitude as compared with the movement of the button, the movement of the last-mentioned member being employed for adjusting the vibratory contact device.

2. Apparatus according to Claim 1 wherein the last-mentioned member consists of a slidable push rod coupled at one end to the said lever and at the other end to a springy plate carrying one of the contacts of the vibrator.

3. Apparatus as claimed in Claim 1 or 2 wherein movement of the button or slidable member first causes the contacts of the vibrator to touch so as to bring the induction coil into action and then gradually reduces the length of the air gap between the vibrator and the core of the induction coil so as gradually to increase the strength of the discharge.

4. A control device for high frequency electro-medical apparatus substantially as herein described and as illustrated in the accompanying drawing.

Dated this 17th day of October, 1938.

HERON ROGERS & CO.,
Agents for Applicant,
Bridge House, 181, Queen Victoria Street,
London, E.C.4.

Leamington Spa: Printed for His Majesty's Stationery Office, by the Courier Press.—1939

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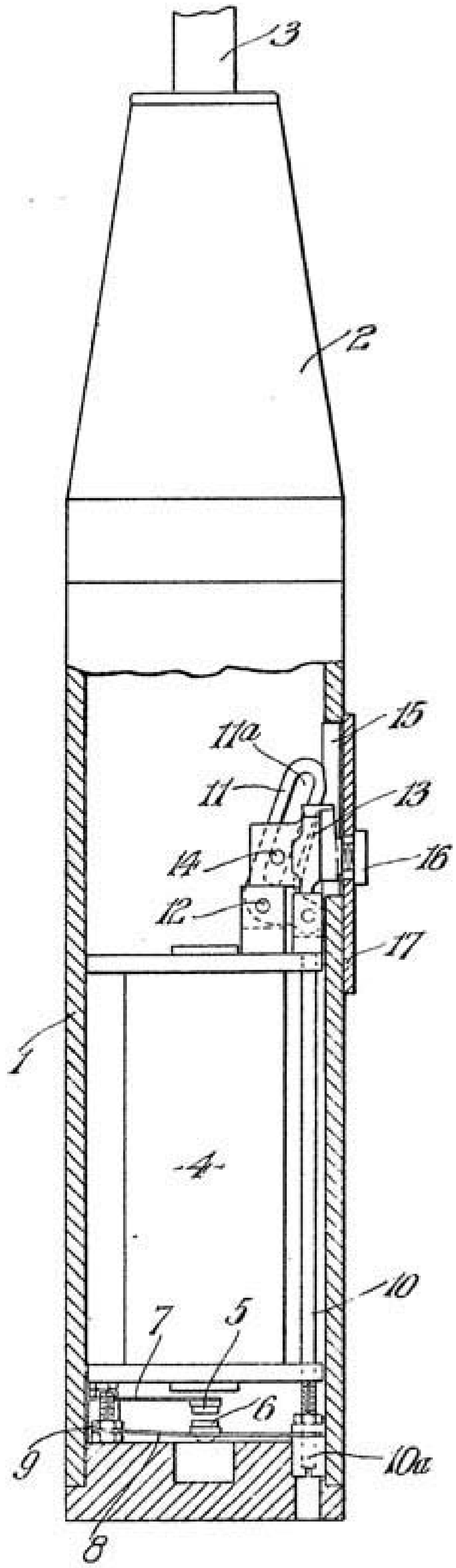

Malby & Sons, Photo-Litho

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PATENT SPECIFICATION

526,802

Application Date: March 24, 1939. *No. 5896/39.*
Complete Specification Accepted: Sept. 26, 1940

COMPLETE SPECIFICATION

Improvements in High Frequency Violet Ray Apparatus

We, CECIL GEORGE LEMON, a British Subject, of 72, North End Road, London, W.14, and CHARLES ARCHELAUS COOPER, a British Subject, of 25, Holborn Viaduct, London, E.C.1, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to high frequency violet ray apparatus for medical treatment with high frequency currents of the kind in which a vacuum-tube electrode or "applicator" is supplied with high frequency current produced by means of an induction coil and a Tesla transformer, the said induction coil and transformer being mounted coaxially in a tubular insulating handle provided at one end with a socket for the reception of the vacuum-tube electrode or "applicator". In this type of apparatus the high tension circuit is contained entirely within the insulating handle and the flexible cable connecting the handle to the main current supply carries current of safe voltage.

The object of the invention is to provide an improved construction of apparatus of the kind above referred to which shall be economical in manufacture and convenient and reliable in use.

According to the invention, the apparatus comprises a main body of tubular construction containing the induction coil and a forward extension fitted with an internal sleeve or tube upon which the Tesla transformer is mounted, one end of the secondary winding of the Tesla transformer being connected to a contact member located inside the said sleeve or tube so as to make contact with a vacuum-tube electrode or "applicator" when the latter is inserted into a socket provided for it in the forward extension.

The nature of the invention and the manner in which the same is to be performed will be fully understood from the following description with reference to the accompanying drawing in which:—

Figure 1 is a sectional view of an appliance constructed according to the preferred form of the invention, and

Figure 2 is a circuit diagram.

In the accompanying drawing, the reference numeral 1 indicates the main tubular body or casing of the appliance, this casing being made of hard vulcanised rubber or other suitable material and being of such dimensions that it can readily be held in the hand.

The casing 1 is closed at its rear end by means of a solid plug or end wall 2 carrying a number of metal rods 3 (two of which can be seen in the drawing) which project forwards into the body 1 and support an induction coil 4, the induction coil being secured to the rods 3 by means of its bobbin flanges 5 and being thus supported within the casing 1 in a position approximately coaxial therewith.

One of the rods 3 projects forwards beyond the forward end of the induction coil 4 and carries a condenser 6 which is thus supported within the body 1 in front of the induction coil.

Attached to the front end of the body 1 is a hollow forward extension 7 made of electrically insulating material which is tapered as shown and is fitted with an internal sleeve or tube 8 of electrically insulating material upon which is mounted a Tesla transformer 9. The part 7 has an axial bore 10 at its forward end so as to enable the shank 11 of a vacuum-tube electrode or "applicator" to be pushed through the bore 10 and into the forward end of the tube 8 which is located in a recess 12 formed as an enlarged diameter continuation of the bore 10. The terminal member on the end of the shank 11 is thus brought into contact with a suitable contact device located inside the tube 8 and connected to one end of the secondary winding of the Tesla transformer. This contact device, which is not shown in the accompanying drawing, may conveniently be arranged as described in specification of copending application for patent No. 28153 of 1937 (Serial No. 513,938).

The inner end of the tube 8 is formed with a flange 13 carrying terminal connectors 14 for the primary winding of

[*Price 3/-*]

Price 33p

the transformer. The annular space between the tube 8 and the outer walls of the forward extension 7 may be filled with paraffin wax 15 or other suitable protective insulating material.

The vibratory contact device 16 of the induction coil is conveniently located between the rear end of the induction coil and the plug 2 and may have a resiliently mounted "fixed" contact 16*a* adapted to be adjusted by means of an external button or slide 17 mounted on the body 1. The button or slide operates a bell crank lever 18 fulcrumed on a bracket 19 fixed to one or more of the rods 3, the movement of the lever 18 being transmitted to the "fixed" contact 16*a* through the medium of a slidable push rod 20. This control mechanism is described and claimed in specification No. 504,345 and need not be further described herein.

The plug 2 carries suitable terminal connectors 21 for connection to two conductors of a flexible cable 22 which is inserted through an opening 23 provided for it in the base plug 2. This cable may be connected to ordinary supply mains or to any other suitable source of current for energising the induction coil 4.

The induction coil has a single winding connected at one end to the vibratory contact 16 and at the other end to one of the supply terminals 21, the other supply terminal 21 being connected to the "fixed" contact 16*a* (see Figure 2). The primary winding of the transformer 9 is connected in series with the condenser 6 across the contacts 16 and 16*a* so that high frequency oscillations are produced in the primary circuit of the transformer when the induction coil is energised. These oscillations are transmitted to the applicator 11 by reason of the electromagnetic and electrostatic coupling which exists between the primary and secondary circuits of the transformer.

In the use of the appliance, the operator grasps the body part 1 and can apply the radiation to any desired part of the body. The flexible cable 22 is required to carry only mains current of comparatively low voltage, the induced current circuit being contained entirely within the handle part of the device.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. High frequency violet-ray apparatus of the kind referred to wherein the handle comprises a main body of tubular construction containing the induction coil and a forward extension fitted with an internal sleeve or tube upon which the Tesla transformer is mounted, one end of the secondary winding of the Tesla transformer being connected to a contact member located inside the sleeve or tube so as to make contact with the vacuum-tube electrode when the latter is inserted into a socket provided for it in the forward extension.

2. High frequency violet-ray apparatus according to Claim 1 wherein the condenser required for the oscillatory circuit is located in the main body between the induction coil and the Tesla transformer.

3. High frequency violet-ray apparatus according to Claim 1 or 2 wherein the induction coil is supported by means of rods upon a plug or end wall which closes the rear end of the main body.

4. High frequency violet-ray apparatus according to Claim 3 wherein the vibratory contact device of the induction coil is located between the rear end of the induction coil and the plug or end wall.

5. High frequency violet-ray apparatus comprising a Tesla transformer, condenser and induction coil mounted in a handle carrying the vacuum-tube electrode or applicator substantially as herein described and as illustrated in the accompanying drawing.

Dated this 24th day of March, 1939.
HERON ROGERS & CO.,
Agents for Applicants,
Bridge House,
181, Queen Victoria Street,
London, E.C.4.

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PATENT SPECIFICATION

Application Date: Apr. 15, 1921. No. 11,069/21.

183,220

Complete Left: Jan. 16, 1922.

Complete Accepted: July 17, 1922.

PROVISIONAL SPECIFICATION.

An Improved High Frequency Electrical Apparatus.

I, Joseph Bernard Bower, of 17, Church Lane, Merton Park, Wimbledon, British subject, do hereby declare the nature of this invention to be as follows:—

This invention, for an improved high frequency electrical apparatus, has for its object to provide a portable and compact apparatus for use on ordinary commercial electric supplies of various pressures to enable currents of much higher frequency than those supplied by commercial electric generating stations, to be obtained; also to provide means for obtaining a second current of low pressure and more normal frequency suitable for heating a cautery instrument or other suitable element for lighting a small lamp.

As is well known, these high frequency currents may be obtained in a circuit containing a properly proportioned induction and capacity by allowing a charge contained in a condenser to be discharged across a spark gap, and through an inductance referred to below as the high frequency coil, the three being connected in series.

A known method of charging the condenser preparatory to this discharge entails the use of a coil known as a kicking coil, and which is in fact a coil wound on a core of iron wires or laminated stampings, so as to have a considerable inductance. The kicking coil is connected to a source of electricity through a switch arranged automatically to open and close the circuit rapidly. The condenser and high frequency coil are joined in series with one another and the remaining sides of the condenser and high frequency coil are connected one to each side of the switch which, when open, acts as the spark gap referred to above.

In order to utilise the high frequency current, it is usual to employ a secondary winding on the high frequency coil, this combination of high frequency coil and its secondary being known as a high frequency transformer.

According to this invention, the kicking coil, together with the switch or contact breaker associated therewith, also the condenser and the high frequency transformer are arranged in compartments formed in a box by vertical partitions secured to a horizontal top plate or inner cover which extends across a portion of the box and carries the terminals, hand switch, contact breaker adjuster and other adjuncts of the apparatus, the said partitions and top plate forming a readily removable support for the various parts of the apparatus, and when in position preferably leaving a free space for the reception of various accessories of the apparatus. A deeply recessed lid is hinged to the back of the box and covers the whole of the top and is provided with spring clips for holding electrodes or other adjustments of the apparatus.

In one way of carrying the invention into practical effect, the main parts of the apparatus are arranged in three separate compartments formed in the box by two parallel vertical partitions extending from a horizontal plate or inner cover portion to the bottom of the box, and a third partition extending along the box at right angles to the others, and dividing the compartmented space from a free space which is left in the box as aforesaid, but is not covered by the inner cover or plate.

The working portion of the apparatus is attached to the various partitions and the inner cover or plate which are of

[*Price* 1/-]

No. 777,290. PATENTED DEC. 13, 1904.

T. B. KINRAIDE.

VARIABLE INDUCTIVE RESISTANCE.

APPLICATION FILED MAY 25, 1904.

NO MODEL.

Fig. 1.

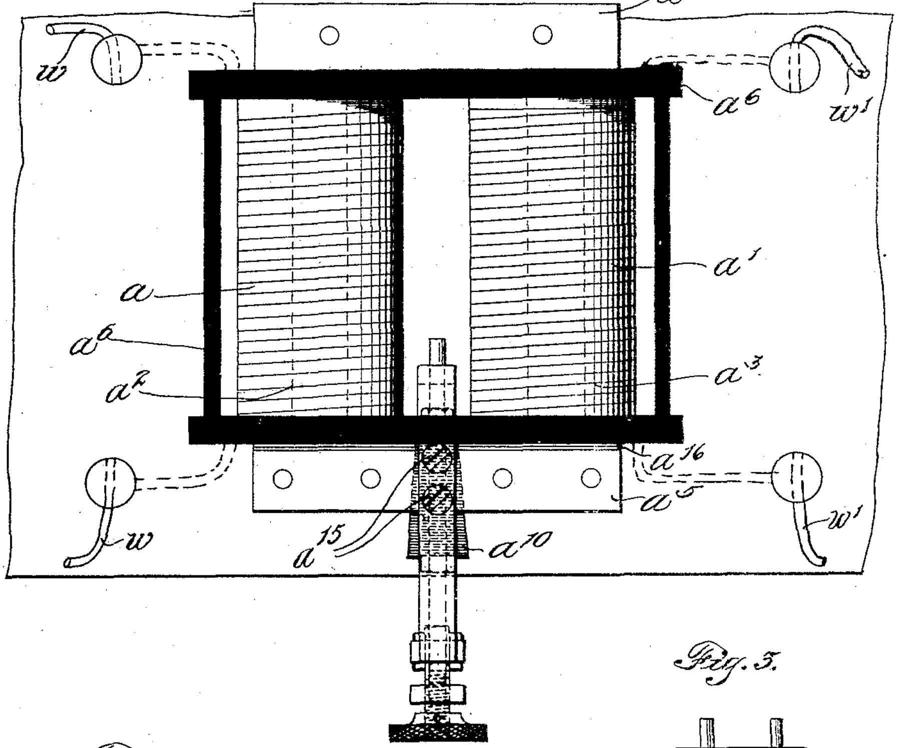


Fig. 2.

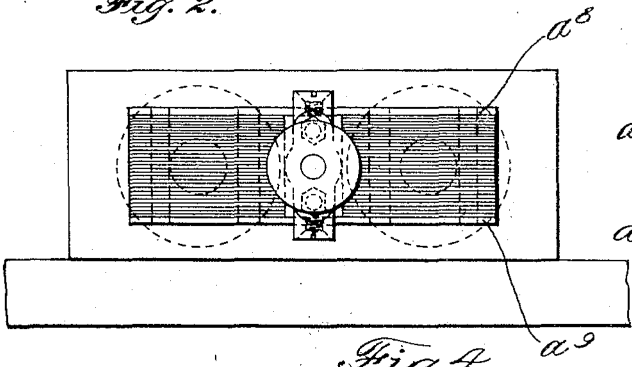


Fig. 3.

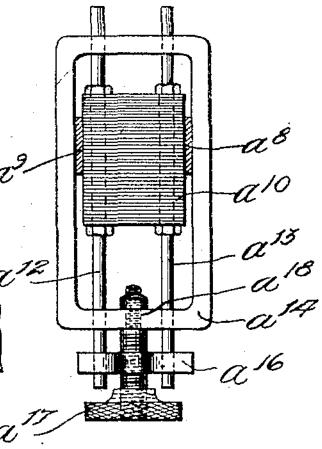
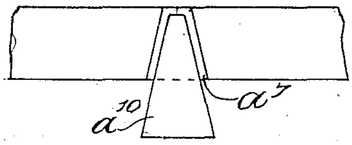


Fig 4



Witnesses:-

John E. Porter.

Robert Ringrose

Inventor;

Thomas B. Kinraide

by Geo. H. Maxwell

Attorney.

PHOTO-LITHOGRAPHED BY SACKETT & WILHELMS LITHO. & PTG. CO. NEW YORK.

No. 777,290. Patented December 13, 1904.

UNITED STATES PATENT OFFICE.

THOMAS B. KINRAIDE, OF BOSTON, MASSACHUSETTS.

VARIABLE INDUCTIVE RESISTANCE.

SPECIFICATION forming part of Letters Patent No. 777,290, dated December 13, 1904.

Application filed May 25, 1904. Serial No. 209,685. (No model.)

To all whom it may concern:

Be it known that I, THOMAS B. KINRAIDE, a citizen of the United States, and a resident of Boston, in the Commonwealth of Massachusetts, have invented an Improvement in Variable Inductive Resistances, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

The present apparatus has for its object the provision of an inductive resistance capable of accurate adjustment for regulating the current without, however, consuming the current so regulated.

The present apparatus is intended to take the place of the resistance-coils or rheostats commonly used in connection with alternating current, which, as is well known, consume all the unused current, acting to cut down the current simply by interposing such an amount of resistance as will use the extra current at that point, and thereby prevent its use farther along.

It is well known that an alternating electric circuit operating in conjunction with a closed magnetic circuit produces the greatest amount of inductive resistance, producing, in fact, resistance to such an extent as to be practically prohibitive of the passage of any current. Accordingly I base my invention upon this fact, my invention residing in providing special means for varying a magnetic circuit used in connection with the alternating current which it is desired to regulate.

In the drawings, in which I have shown a preferred embodiment of my invention, Figure 1 is a top plan view of one form of the apparatus. Fig. 2 is a front end elevation. Fig. 3 is a vertical cross-sectional view showing the adjustable wedge or air-gap adjuster in said elevation. Fig. 4 is a fragmentary view, largely diagrammatic, for illustrating the theory of operation of the device.

The general features of construction used in connection with my invention resemble a pair of solenoids whose cores are joined to form a closed magnetic circuit comprising opposite coils a a' (connected, respectively, in series with the wires w and w' of the main circuit) of coarse wires wound about cores a^2 a^3, magnetically connected in a closed circuit at their opposite ends by laminated armatures a^4 a^5, all supported in an ebonite or other suitable frame a^6.

The purpose of my invention is to provide means for varying the magnetic circuit from a closed magnetic circuit to a more or less open magnetic circuit, and while this may be accomplished in various ways I prefer to secure the desired result by interposing an air-gap. For this purpose I cut the laminæ at one end of the instrument, herein shown as the laminæ a^5, transversely, so as to effect a slightly wedge-shaped opening a^7, this opening being bridged on its upper and under sides by two non-magnetic pieces a^8 a^9 for giving the desired strength and permanence of position. In this opening a^7 I mount a wedge-shaped member a^{10}, also preferably laminated, the laminæ, however, extending vertically, as is clearly shown in Figs. 1 and 3, instead of extending horizontally, as the other laminæ, a^5 a^4, do. The opposite sides of this wedge are only slightly divergent, extending approximately at right angles to the path of the magnetic flux, thereby reducing the pull thereon, and hence there is no special strain or tendency thereof to move under the inductive influence of the alternating current. In order to still further render the same rigid, however, and also to insure precision of movement under all circumstances, as is necessary in order to maintain the air-gap even and uniform in its various adjustments, I mount the air-gap adjuster or wedge device a^{10} on guide-rods a^{12} a^{13}, slidingly mounted in a frame a^{14}, secured fast to the plates a^8 a^9, as indicated at a^{15}. On the outer ends of these rods a^{12} a^{13} is secured a cross bar or nut a^{16}, and in this nut a thumb-screw a^{17} works, being swiveled at a^{18} in the end of the frame a^{14}, so as to turn easily therein without moving longitudinally.

From the foregoing description it will be evident that simply by adjusting the thumb-screw a^{17} slightly one way or the other the most delicate adjustment of the wedge a^{10}

takes place, thereby regulating with extreme accuracy and nicety the air-gap a^7 for varying the magnetic field from a closed circuit, where the flow of current is practically stopped, to an open circuit in which merely the phenomena of the ordinary inductance-coil—*i. e.*, simply a coil around a core with an open magnetic field—takes place and the flow of current is only slightly checked.

As already stated, this device is to be used with an alternating current which operates in connection with a magnetic field as follows: Having produced the magnetic field by a wave of current flowing in one direction, the succeeding wave, flowing in the opposite direction, demagnetizes the same field, which produces a counter electromotive force in the winding, thus holding back the flow of the main current, and so on with each succeeding alternation, each wave first demagnetizing the previous polarity, thereby creating a counter electromotive force which suppresses further flow of current. The winding should have a sufficient number of turns to produce a counter electromotive force equal to that of the main current. When the magnetic field is entirely closed, the alternating current is not only checked, but practically stopped, and by reason of the delicate adjustment of the air-gap the magnetic field is rendered more or less closed, according to the effect which it is desired to produce upon the passage of the alternating current. The current is simply checked or stopped to a more or less degree, according to the adjustment of the air-gap, and is not consumed, and hence a great saving of power at the source of energy takes place.

In constructing my apparatus I prefer to interpose one or more sheets of mica or other insulation in the magnetic field, as indicated at a^{16}, for the purpose of originally regulating the instrument to the minimum amount of current to which it is desired to respond. For instance, it is convenient to have the apparatus originally built to permit the flow therethrough of a certain fixed minimum current when the air-gap is entirely closed, and this is accomplished by interposing in the field a certain fixed barrier to the magnetic flux.

From the foregoing description it will be evident that my invention is capable of a wide variety of embodiments, and accordingly I do not intend to limit myself to the form, arrangement, and specific combination of parts herein set forth, excepting as otherwise specified in the claims.

Having described my invention, what I claim as new, and desire to secure by Letters Patent of the United States, is—

1. A variable inductive resistance for the purpose set forth, comprising opposite, independent coils formed respectively in the opposite sides of an alternating-current circuit, a magnetic field including opposite cores for said coils, and mechanical means for varying the magnetic influence of said field on the current of said coils.

2. A variable inductive resistance, comprising opposite, independent coils respectively in the opposite sides of an alternating-current circuit, cores therefor, magnetic connections at the opposite ends of said cores, a transverse wedge-shaped air-gap in one of said connections, and a wedge-shaped member for regulating the resistance of said air-gap.

3. A variable inductive resistance, comprising a magnetic field including opposite cores, independent windings on said respective cores adapted to be connected to the opposite sides of an alternating-current circuit, said magnetic field having interposed therein a fixed magnetic resistance determining the minimum amount of current transmissible through the apparatus.

4. A variable inductive resistance, comprising a magnetic field including opposite cores, independent windings on said respective cores adapted to be connected to the opposite sides of an alternating-current circuit, said magnetic field having interposed therein an insulating-barrier for determining the minimum amount of current transmissible through the apparatus.

5. A variable inductive resistance, comprising a magnetic field including opposite cores, independent windings on said respective cores adapted to be connected to the opposite sides of an alternating-current circuit, said magnetic field having a thin barrier of insulation extending transversely across one end of one of said cores for rendering it impossible entirely to close the magnetic field.

6. A variable inductive resistance, comprising a magnetic field including opposite cores, independent windings on said respective cores formed respectively in the opposite sides of an alternating-current circuit, said magnetic field having interposed therein a wedge-shaped air-gap, a frame mounted rigidly thereat, slides movable in said frame, a wedge-shaped magnetic member, carried by said slides, and adjusting means for moving said member toward and from said air-gap.

7. A variable inductive resistance, comprising an approximately closed magnetic field including opposite cores, independent windings on said respective cores, said magnetic field at one end of said respective cores having an air-gap formed therein, insulating-plates connecting said cores and bridging said air-gap, a magnetic closing member for regulating the extent of said air-gap, a frame carrying said member, and means for adjusting said member with relation to said air-gap.

8. A variable inductive resistance, having a magnetic field, provided with a transverse air-gap, and a magnetic closing device therefor, the adjacent side of said closing device extending approximately at right angles to the normal path of the magnetic flux.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

THOMAS B. KINRAIDE.

Witnesses:
Geo. H. Maxwell,
R. S. Ford.

T. B. KINRAIDE.

APPARATUS FOR FORMING A SMOOTH SURFACE ON METAL WHILE BEING MILLED.

APPLICATION FILED MAY 13, 1918.

1,336,239. **Patented Apr. 6, 1920.**

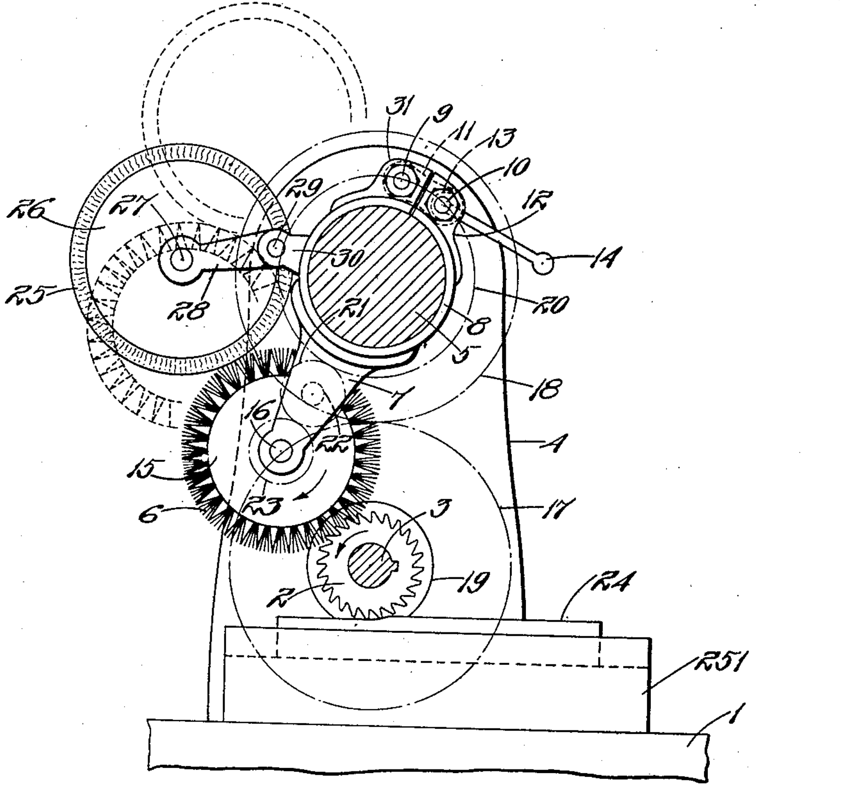


Fig. 1.

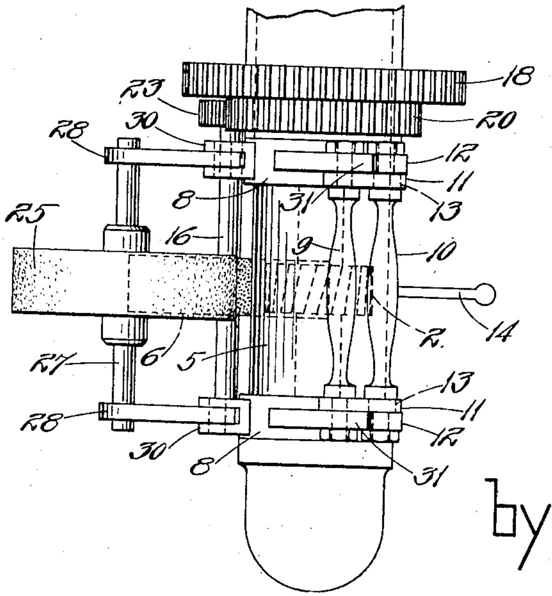


Fig. 2.

Inventor:
Thomas B. Kinraide
by Macleod, Calver, Copeland & Dike
Attys.

UNITED STATES PATENT OFFICE.

THOMAS B. KINRAIDE, OF BOSTON, MASSACHUSETTS.

APPARATUS FOR FORMING A SMOOTH SURFACE ON METAL WHILE BEING MILLED.

1,336,239. Specification of Letters Patent. **Patented Apr. 6, 1920.**

Application filed May 13, 1918. Serial No. 234,260.

To all whom it may concern:

Be it known that I, Thomas B. Kinraide, a citizen of the United States, residing at Boston, county of Suffolk, State of Massachusetts, have invented a certain new and useful Improvement in Apparatus for Forming a Smooth Surface on Metal while being Milled, of which the following is a specification, reference being had therein to the accompanying drawings.

In the use of machines for milling down the surface of metallic bars or thinning down the bars to bring them to the requisite thickness, that is, surfacing them, as it is termed in the trade by the use of milling cutters, and of other cutters, it is well known that the chips formed by the cutter adhere to the cutting edges of the blades or teeth more or less, thus absolutely preventing a perfectly smooth surface being formed on the bar which is being worked, and in fact often times after a few turns of the cutter the chips accumulate so that by reason of their burring effect on the surface of the bar while the cutter is in operation, the surface of the bar becomes very much roughened. The softer the metal of the bar which is being worked, the rougher will be the surface after the cutter has been over it. This is noticeable to some extent in steel bars but it is especially noticeable in the softer metals such as aluminum, copper and lead. In copper and lead it is true to a very marked degree.

In many kinds of construction where metal bars are employed, it is extremely important, in fact absolutely necessary, that the surfaces shall be very smooth, for instance in the construction of crank cases for automobiles where it is important that the joints shall be very tight, the overlapping surfaces at their joints should be very smooth. It is also essential in aeroplane construction where aluminum is used to a considerable extent.

One object of the present invention is to provide a method of thinning down a metallic bar or plate and at the same operation forming a smooth surface on the face of the metal, said method consisting of surfacing the bar or plate by a cutter and clearing the cutting edge of the cutter automatically each time that the cutting edge passes out of contact with the metal plate before it again comes into operative contact with the plate.

Another object of the present invention is to provide an attachment for a milling machine which can be readily attached to the milling machines in ordinary use to automatically free the cutting edges of the blades of the milling cutter from the chips as fast as they are formed. Another object of the invention is to provide means for connecting the attachment with the milling machine in such manner that the cleaning device may be adjusted when desired, either in an operative position with relation to the milling cutter or out of operative position as desired.

The invention will be fully understood from the following description when taken in connection with the accompanying drawings and the novel features thereof will be pointed out and clearly defined in the claims at the close of this specification.

In the drawings, Figure 1 is a view in elevation, partly in section, of a portion of a milling machine, having attached thereto one form of a device embodying the invention.

Fig. 2 is a plan view of a portion of the top of the milling machine and the attachment embodying the invention.

Referring now to the drawings, 1 is a platen of a milling machine, partly broken away, the lower portion of the machine being omitted. A milling cutter 2 is mounted on an arbor 3 which is journaled in the column or arbor support 4. The arbor 3 is driven by any suitable mechanism. A horizontal arm 5 is mounted on the upper part of the arbor support 4, and mounted on said arm 5 is a yoke or hanger in which is journaled a rotary brush 6. In the form of device shown in the drawings, the hanger in which the brush 6 is journaled comprises two depending arms 7 parallel with each other which are respectively provided at their upper ends with straps 8 which encircle the arm 5, each of said straps being split transversely so that the strap may be spread open somewhat to permit its adjustment on the arm 5. Each strap has a boss 31 on the outer periphery near one end, which is connected with the boss on the corresponding end of the other strap by a tie rod 9, and the other ends of the two straps are connected together by a tie rod 10 which is journaled in the two bosses 12, 12 on the outer periphery of the two straps near the said other ends. The two tie rods are connected together by links 11, 11. An eccentric 13 is carried by the rod 10 at each end thereof. The rod 10 is provided with a lever arm 14 whereby said arm may be rotated. By rotating the said rod 10 the eccentrics 13, 13 are rotated in a manner to close or open the straps 8, 8 according to the direction of rotation of the eccentric, thereby causing the straps to grip or loosen their hold as the case may be on the arm 5. The straps are loosened for the purpose of permitting adjustment of the hanger on the arm 5 and are tightened again to clamp the hanger in its adjusted position. When the straps are loosened the hanger may be turned on the arm so as to swing the brush up out of contact with the cutter, as shown in dotted lines in Fig. 1, and the straps may then be tightened to hold the brush in the said inoperative position.

The brush 6 is preferably a bristle brush of cylindrical form, the tufts of the bristles being set into a cylindrical head 15 which is mounted fast on a shaft 16. The bristles are preferably short and stiff. Said shaft 16 is journaled in the depending arms 7 of the hanger.

By properly adjusting the hanger radially on the arm 5 the brush may be positioned so that the bristles will engage with the blades of the milling cutter 2 as shown in Fig. 1.

For the purpose of cleaning the blades of the cutter 2 the brush 6 should be rotated continuously when the cutter 2 is being rotated, and it is important that it should be driven in a direction so that the bristles of the brush will engage particularly with the cutting edges of the blades of the cutter, hence they should be rotated so that the travel of the blades and of the bristles of the brush will be in the same direction when they are in contact with each other, but at different speeds. It is preferable to have the brush travel faster than the cutter. Any suitable means of accomplishing this result may be employed. The means shown are as follows:

Mounted on the end of the spindle 19 which carries the cutter arbor 3 is a driving gear 17 which engages with a gear 18 mounted on the arm 5, the said two gears 17 and 18 being as one to one. Mounted fast on arm 5 is a gear 20 of smaller diameter than the gear 18. As shown in the drawings, gear 20 is formed integral with the gear 18. Said gear 20 engages with an idler 21 mounted on a stud 22 carried in one of the arms 7 and said idler engages with a gear 23 mounted on the brush shaft 16. The gears 20 and 23 are shown as proportioned three to one, so that the brush will make three revolutions while the cutter 2 makes one revolution. It will thus be seen that when the parts are adjusted as in Fig. 1, during the rotation of the milling cutter the brush will be constantly traveling at a greater rate of speed than the cutter and will be operative on the front or cutting edges of the blades of the cutter 2 and thoroughly clean the cutting edges of the blades from the chips of the metal which may be cut away from the surface of the bar which is being milled. The bristles being short and stiff and the cutter constantly turning its blades into the ends of these bristles, this causes a powerful thrust upon the particles of metal adhering to the blade so that the brush has two functions, it not only acts as a brush to wipe the particles from the blades, but it also acts as a matting tool upon the adhering particles and thrusts them away from the cutting edge. The drawing shows a bar 24 mounted on the feed block 251 in the process of being milled.

I have found that the chips or fine particles of metal which are cut from the bar which is being operated upon are less likely to adhere to the cutter, or if they do adhere to the cutter, they are more easily brushed away, if the blades of the cutter are kept oiled. Inasmuch as it is not desired to have a large amount of oil on the cutter at any time, but rather to keep the blades slightly oiled all of the time, I have found it productive of good results to keep the brush 6 oiled and to oil the blades by means of the brush 6 at the same time that the brush cleans the blades. In order to keep the brush 6 constantly oiled without dripping I provide an oiling roll which is of the same width as the brush and against which the brush will contact during its rotation.

This oiling roll is preferably a pad of felt 25 or other equivalent material mounted on the periphery of a wooden core 26. The said roll is mounted loosely on a shaft 27 so as to be rotatable thereon. Said shaft 27 is mounted fast in the arms 28 which are pivotally connected at 29 with arms 30 which project from the outer periphery of the straps 8 of the hanger which carries the brush. By reason of the pivot connection of the arms 28 with the straps 8 the oiler roll 25 will when the device is mounted as shown in Fig. 1, drop by gravity into contact with the brush roll 6.

The pad 25 is sufficiently saturated with oil so that as the brush in its rotation engages the periphery of the oil pad the bristles of the brush will be constantly reoiled.

The oil roll need not have any independent means for rotating the same but it will be caused to rotate by its frictional contact with the brush so that all portions of the periphery of the oil roll will successively be brought into operative contact with the brush.

While I have described one form of attachment for a milling machine whereby the blades of the cutter are cleaned automatically during the rotation of the cutter, I do not intend to limit the claims to the particular form of mechanism shown, said mechanism being illustrative of one form of means for cleaning the blades. My invention resides broadly in the idea of automatically cleaning the cutting edges of the blades during the movement of the cutter after each operative contact of a blade before it again comes into operative engagement with the metal which is being milled, or in other words, it resides broadly in the method of cutting down the surface of a metal plate in such manner as to constantly leave a smooth surface where it is milled down, said method consisting of removing the metal from the surface by a cutter and cleaning the cutting edge of each blade automatically each time after it leaves the metal before it again comes into contact with the metal.

What I claim is:

1. In combination with a milling machine having a rotary cutter, a rotary bristle brush whose axis extends parallel with the axis of the cutter, a yoke in which said brush is journaled, a supporting shaft parallel with the axis of said brush, means for adjustably securing said yoke to said shaft to maintain the brush parallel with the axis of the cutter, the yoke being adjustable to change the position of the brush toward and away from the cutter, and means for maintaining the yoke in its adjusted position, so that the brush may be maintained either in engagement with the cutter or entirely free from the cutter, as desired.

2. In combination with a milling machine having a rotary cutter, a rotary brush whose axis is parallel with the axis of the cutter, a mount in which said brush is journaled, so located that the brush engages with the cutter during the rotation, and a rotary oiling roll which engages with the periphery of the brush throughout the length of the brush, and bears with a pressure on said brush.

3. In combination with a milling machine having a rotary milling cutter, a rotary brush whose axis extends parallel with the axis of the cutter, and means for supporting said brush in relation to the said cutter, said supporting means comprising a shaft which extends parallel with the axis of the brush and of the cutter, a strap adjustably secured to said shaft, an arm projecting from said strap and having bearings in which said brush is journaled, said strap being adjustable on said shaft whereby the bearing for the brush is radially adjustable to vary the position of the brush with relation to the cutter.

4. In combination with a milling machine having a rotary milling cutter, a rotary brush whose axis extends parallel with the axis of the cutter, and means for supporting said brush in relation to the said cutter, said supporting means comprising a shaft which extends parallel with the axis of the brush and of the cutter, a strap adjustably secured to said shaft, an arm projecting from said strap and having bearings in which said brush is journaled, said strap being adjustable on said shaft whereby the bearing for the brush is radially adjustable to vary the position of the brush with relation to the cutter, an oiling roll and an arm projecting from said strap with which said oiling roll is pivotally connected in such manner that the oiling roll bears upon the periphery of said brush.

5. In combination with a milling machine having a rotary milling cutter, a rotary brush located in position to engage the blades of the cutter during the rotation, and an adjustable mount for the brush, said mount being adjustable to bring the brush into position to engage the blades of the cutter and to shift the brush out of engaging position, and means for maintaining the mount with the brush in the adjusted position, either in engagement with the cutter or entirely free from engaging position with the cutter, as desired.

6. In combination with a machine having a rotary milling cutter, a rotary brush, means for holding the brush so that it may at will be located in position to engage the blades of the cutter during the rotation or in a position where it will be out of engagement with the cutter, and means for maintaining the brush in the adjusted position, either in engaging position with the cutter or entirely out of engaging position as desired.

7. In combination with a milling machine having a rotary milling cutter, a brush which extends alongside of the cutter its full length, means for holding the brush in a position to engage the blades of the cutter during the rotation, means for rotating both the brush and the cutter, and a rotary oiling member which engages with the brush throughout the entire length of the brush and thereby applies oil to the brush as the brush and oiling member rotate in engagement with each other.

8. In combination with a milling machine having a rotary milling cutter, a rotary bristle brush, means for holding the brush in a position to engage the blades of the cutter during the rotation, means for rotat-

ing the cutter and the brush, and means for automatically applying oil to the said brush during the rotation.

9. In combination with a milling machine having a rotary cutter, a rotary bristle brush, means for holding the brush in a position to engage the blades of the cutter during the rotation, means for rotating the cutter and the brush, a second rotary member located in position to engage said bristle brush, said second rotary member being provided with an oil pad on its periphery whereby it maintains the ends of the bristles of said first brush in an oily state.

In testimony whereof I affix my signature.

THOMAS B. KINRAIDE.

Eigenthum des Kaiserlichen Patentamts.

KAISERLICHES PATENTAMT.

AUSGEGEBEN DEN 2. MÄRZ 1900.

PATENTSCHRIFT

— № 108924 —

a. Gruppe ~~6~~ 9

KLASSE 21: Elektrische Apparate und Maschinen.

THOMAS BURTON KINRAIDE in JAMAICA-PLAIN (Mass., V. St. A.).

Vorrichtung zur Erzeugung elektrischer Entladungen.

Patentirt im Deutschen Reiche vom 21. März 1899 ab.

Die neuerliche Entwickelung auf elektrischem Gebiet, insbesondere in Richtung der experimentellen Arbeit mit statischer Elektricität erfordert Entladungen von solch enormem Potential bezw. Mengen aufgespeicherter Elektricität, daſs die üblichen Vorrichtungen, indem sie sehr rasch unwirksam werden oder der Zerstörung unterliegen, unzureichend geworden sind.

Dieser Uebelstand wird der vorliegenden Erfindung gemäſs beseitigt durch die Verwendung des bekannten Kohlrausch'schen Plattencondensators als Funkengeber zur Erzeugung oscillirender Entladungen, d. h. es wird die Entladung bewirkt vermittelst zweier unter Belassung eines Funkenraumes streng parallel zu einander angeordneten Flächen von groſser Ausdehnung.

Die Erfindung ist in zwei Beispielen in den beiliegenden Zeichnungen veranschaulicht.

Fig. 1 zeigt in Seitenansicht eine sehr einfache Ausführungsform und

Fig. 2 in gleicher Darstellung eine mit Kühlvorrichtung für die Entladungsplatten versehene Abänderung; Fig. 3 ist die Oberansicht zu Fig. 2.

Die Entladungselektroden bestehen aus den metallenen Platten oder Scheiben $g\,g^1$, welche, mit möglichst ebener Oberfläche versehen, streng parallel zu einander angeordnet sind; der Luftraum zwischen den Platten bildet den Funkenraum. Je gröſser die Scheiben sind, um so gröſsere Condensatorcapacität besitzen sie, und durch einen um so weiteren Zwischenraum lassen sie Funken überschlagen.

Die Scheiben bezw. Platten $g\,g^1$ sind behufs Aenderung des Widerstandes des zwischengeschalteten gasförmigen Dielektrikums verstellbar gemacht. Aus den Zeichnungen, in denen die hierzu vom Erfinder angewendete Einrichtung veranschaulicht ist, ersieht man, daſs eine Anzahl Säulen g^2 angeordnet ist, auf deren obere mit Gewinde versehene Enden Muttern g^3 geschraubt sind mit Schultern zum Aufsetzen der oberen Scheibe oder Platte g^1.

Die Gegenscheibe g ruht auf einer Unterlage oder einem Tisch g^4; sie ist lose in einem Säulchen g^5 gehalten und wird für gewöhnlich gegen ihre Unterlage gezogen durch eine Schraubenfeder g^6, welche in einem von der Unterlage herabhängenden Gehäuse g^7 angeordnet ist. Diese Feder g^6 stützt sich mit dem unteren Ende gegen den Boden des Gehäuses und mit dem oberen Ende gegen eine Scheibe g^8, welche durch eine Schraube g^9 festgehalten ist, deren Kopf in der Scheibe g zur Centrirung derselben versenkt ist. Die Scheibe g ist auf der Unterseite mit einer Anzahl, auf der Zeichnung z. B. drei, Vertiefungen versehen zur Aufnahme der oberen Enden von Stützen g^{10}. Letztere sind von genau gleicher Länge, so daſs sie die Scheibe g absolut parallel zur Gegenscheibe g^1 halten. Von der Unterseite der Unterlage g^4 ragt nach unten ein Zapfen g^{11} (Fig. 3), welchen das gegabelte Ende g^{12} eines Hebels g^{13} umfaſst, der in g^{14} drehbar auf einer Säule g^{15} gelagert ist. Infolge dieser Einrichtung ist die genaueste Einstellung in einfacher Weise ermöglicht, indem man durch Drehen des Hebels (nach der einen oder anderen Seite) den Stützen g^{10} eine gröſsere oder geringere Neigung ertheilen und

dadurch den Abstand zwischen den Scheiben $g\,g^1$ entsprechend vergröſsern und verringern kann. Die Muttern g^3 dienen gröberer Einstellung durch Heben oder Senken der oberen Scheibe.

In den Fig. 2 und 3 sind hohle Scheiben $g\,g^1$ in Verbindung mit Wassercirculationsröhren g^{16} gezeigt, um jeder Erwärmung unter auſsergewöhnlichen Umständen begegnen zu können. Für gewöhnliche Umstände ist diese Vorkehrung völlig überflüssig.

Sind die Scheiben auf den Entladungsflächen vollständig oxydirt, so kann man sie umwenden und die Kehrseiten als Entladungsflächen benutzen. Sind auch diese oxydirt, so kann man die Scheiben leicht herausnehmen und blank machen, ohne eine ihrer Einstellungen zu zerstören.

Die Erfindung ermöglicht unter Entwickelung von nur wenig Wärme die jähe Entladung eines Condensators bei Erreichung einer bestimmten Ladung unter Erzeugung von Oscillationen, wie sie mit gleicher Rapidität, Kürze und Schärfe vermittelst der Entladung zwischen Kugel und Spitze nicht erzielbar sind.

PATENT-ANSPRÜCHE:

1. Eine Vorrichtung zur Erzeugung elektrischer Entladungen, gekennzeichnet durch die Verwendung des Kohlrausch'schen Plattencondensators als Funkengeber.
2. Eine Ausführungsform der unter 1. geschützten Vorrichtung, bei welcher eine der Entladungsoberflächen von drei oder mehr Stützen von gleicher Länge getragen wird, welche so angeordnet sind, daſs sie zur Regelung des gegenseitigen Abstandes der Entladungsflächen zusammen geneigt werden können.
3. Eine Ausführungsform der unter 1. geschützten Vorrichtung, bei welcher die Entladungsoberflächen mit Circulationsvorrichtung behufs Durchleitung von Kühlwasser versehen sind.

Hierzu 1 Blatt Zeichnungen.

BERLIN. GEDRUCKT IN DER REICHSDRUCKEREI.

THOMAS BURTON KINRAIDE in JAMAICA-PLAIN (Mass., V. St. A.).

Vorrichtung zur Erzeugung elektrischer Entladungen.

Fig. 1.

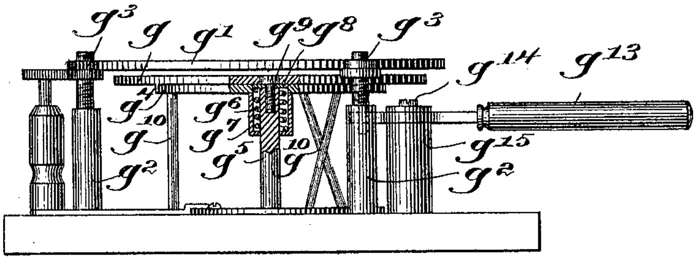


Fig. 3.

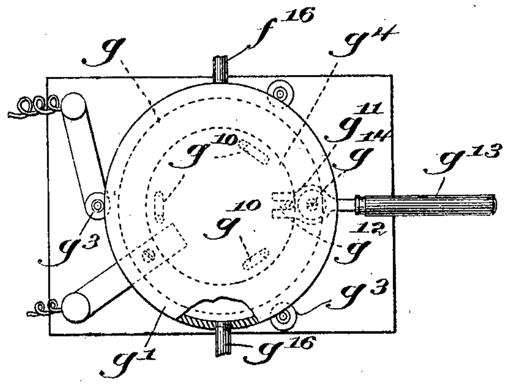
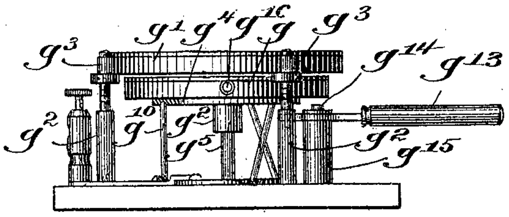


Fig. 2.



Zu der Patentschrift

№ 108924.

PHOTOGR. DRUCK DER REICHSDRUCKEREI.

No. 785,671. PATENTED MAR. 21, 1905.

H. JACKSON.

DETONATOR OR AUXILIARY PROTECTIVE ALARM SPARK GAP FOR HIGH FREQUENCY APPARATUS.

APPLICATION FILED JULY 27, 1904.

Fig. 1.

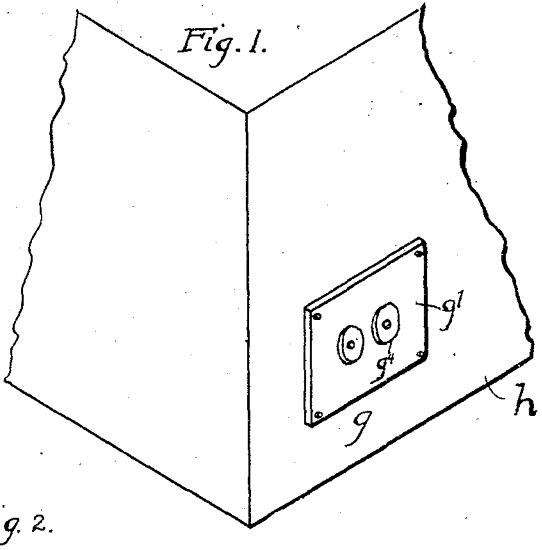


Fig. 2.

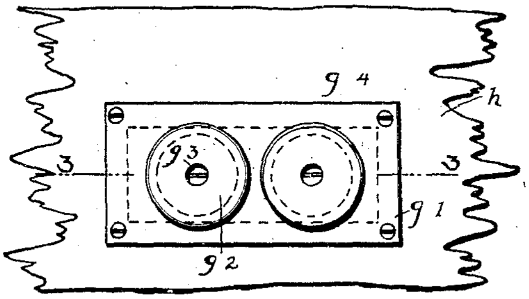


Fig. 3.

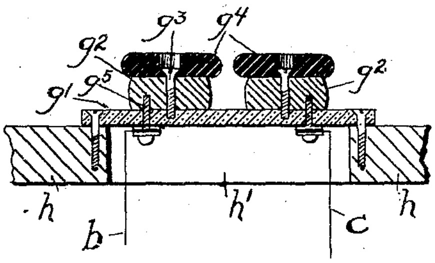
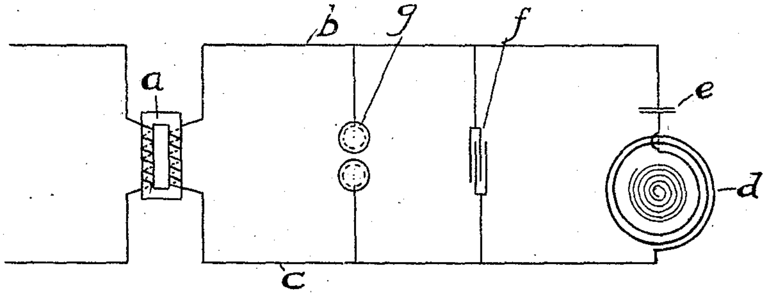


Fig. 4.



WITNESSES

Wm. L. Farrar,

J. B. Jackson.

INVENTOR

Howard Jackson

BY Geo. H. Maxwell

ATTY.

PHOTO-LITHOGRAPHED BY SACKETT & WILHELMS LITHO. & PTG. CO. NEW YORK.

No. 785,671. Patented March 21, 1905.

UNITED STATES PATENT OFFICE.

HOWARD JACKSON, OF NEWTON, MASSACHUSETTS.

DETONATOR OR AUXILIARY PROTECTIVE ALARM SPARK-GAP FOR HIGH-FREQUENCY APPARATUS.

SPECIFICATION forming part of Letters Patent No. 785,671, dated March 21, 1905.

Application filed July 27, 1904. Serial No. 218,438.

To all whom it may concern:

Be it known that I, HOWARD JACKSON, a citizen of the United States, and a resident of Newton, Massachusetts, have invented an Improvement in Detonators or Auxiliary Protective Alarm Spark-Gaps for High-Frequency Apparatus, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

The increased efficiency of high-frequency apparatus of the kind employed in connection with X-ray work, therapeutical work, and the like has occasioned the placing in the hands of novices and the unskilled of apparatuses more or less complex and requiring heavy and dangerous currents; and the present invention has for its object the provision of protecting mechanism for the apparatus in the form of means for automatically notifying the user of such apparatus in case anything goes wrong.

My invention includes in its preferred embodiment means for promptly notifying the user both by sound and sight and also by the sense of smell whenever an open circuit or other breakdown occurs.

The constructional details of my invention and the operation thereof and further resulting advantages will appear more fully in the course of the following description, reference being had to the accompanying drawings, in which I have illustrated one embodiment of my invention.

In the drawings, Figure 1 is a fragmentary view of a cabinet, showing my invention applied thereto. Fig. 2 is an enlarged front elevation thereof. Fig. 3 is a cross-sectional view taken on the line 3 3, Fig. 2. Fig. 4 is a diagrammatical view showing the circuit connections

In many ways a breakdown is liable to occur in the use of the kind of apparatus in question—as, for example, if the spark-gap be improperly connected or accidentally omitted (as it often is for removal in cleaning or renewing) and the current is turned on the back discharge from the condenser will break down the insulation of the transformer—or the conductors from the condenser to the induction-coil or step-up transformer may become detached or imperfectly attached, in which case the whole output is thrown into the condenser and not having any other path to discharge excepting through the transformer immediately punctures the insulation thereof, as before. Accordingly I have provided an auxiliary device in the form of a spark-gap permanently in circuit and so situated as to be plainly visible at all times, being preferably on the outside of the box or case in which the apparatus is situated and also preferably containing means for giving off an offensive or pungent odor when heated, said auxiliary spark-gap being so adjusted as to be inoperative when the main circuit is working normally, but becoming operative instantly when the main circuit operates abnormally.

My invention is capable of a wide variety of embodiments, the form herein shown, however, being preferred because of its neat appearance, compact arrangement, and certainty and efficiency of action.

Referring to Fig. 4, I have indicated a transformer *a*, connected by wires *b c* to an induction-coil *d*, a Kinraide coil being shown for convenience, (see Patent No. 615,653, December 6, 1898,) operated in connection with a spark-gap *e* and a condenser *f* in the usual manner. I introduce across the circuit an auxiliary spark-gap or detonator *g*, being herein shown as between the transformer *a* and the condenser *f*, although it is obvious that it may be on the other side thereof or otherwise located, provided it is connected around the part or parts which are liable to cause the trouble. The constructional details of the preferred embodiment of this auxiliary spark-gap or detonator are shown best in Figs. 2 and 3, where it will be seen that the box or cabinet *h* is cut away at *h'* to provide a free and unrestricted opening to the interior, and over this opening *h'* I secure a heavy insulating-block *g'*, of porcelain, glass, or other suitable non-inflammable material, on which are mounted opposite electrodes or discharge-buttons g^2, shown as retained by screws g^3, which also serve to retain protectors g^4 of hard rubber or other insulating and odoriferous material. Binding-posts g^5 connect the wires *b c* at their inner ends and engage the electrodes g^2 as far apart as possible to prevent any danger of sparking across on the inside of the box. To make a distinctive and very loud noise and also to prevent any preliminary brush discharges, which might cause a sudden discharge, tending to annoy and interfere with the steadiness of the main apparatus, I make the electrodes g^2 g^2 circular in form, with rounded edges. This permits the electrodes to be brought almost as close together as the plates of the main spark-gap, without any tendency, however, to operate during the normal operation of the apparatus. The protectors g^4 are the same shape as the electrodes g^2 and overhang the latter, so as to prevent the operator from accidentally coming in contact with said electrodes, and yet leave the latter sufficiently exposed to permit the free circulation of air and to permit the arc to be visible whenever the detonator is called into action. The electrodes g^2 g^2 are adjusted apart sufficiently to provide a slightly greater resistance than that of the coil *d* and spark-gap *e*, which carry the oscillating current from the condenser, the adjustment of the device *g* determining the amount of strain that can be thrown upon the apparatus. This amount of strain will usually be greater or less, according to the character of the insulation of the transformer *a*. The latter is one of the most expensive portions of such an apparatus, and hence it is desirable to protect it in any event, and therefore the electrodes g^2 g^2 are usually adjusted from each other such a distance as to give prompt notice of any back discharge from the condenser or other similar danger liable to break down the insulation of the transformer.

In use if the apparatus is in proper condition, with all the parts properly adjusted and connected, the current passes in usual manner from the transformer *a* by the conductors *b c* to the condenser, whose discharges are passed through the coil *d* by the action of the spark-gap *e*. If now anything should occur to increase the resistance of the circuit or cause a breakdown therein, the current will immediately set the detonator *g* in operation, preferring this path of relatively low resistance to overcoming the impedance of the transformer, causing a loud and startling noise because of the discharge between the electrodes g^2 g^2, and as the device *g* is in plain sight the blinding light therefrom will also attract attention, and simultaneously therewith the smoking of the rubber protectors g^4 will compel attention by the sense of smell. Thereupon the operator instantly shuts off the current and is then at liberty to investigate at his leisure the cause of the trouble.

It will be evident that the apparatus may be guarded with any degree of nicety desired, according to the distance apart of the electrodes g^2 g^2. The auxiliary spark-gap or detonator remains idle or inactive at all times during the proper running of the apparatus to which it is applied, but is ever present and effective for warning the operator of any dangerous tendency of the condenser-current to flow back to the transformer. It does not depend in any way upon any special winding or contain any spring-actuated device or other movable parts; but it consists simply of a spark-gap not requiring any skill or understanding or attention on the part of the operator.

As already intimated, I am aware that many changes in form, arrangement, and combination of parts may be resorted to without departing from the spirit and scope of my invention.

Having fully described my invention, what I claim, and desire to secure by Letters Patent of the United States, is—

1. An apparatus of the kind described, comprising an electric circuit, a cabinet, containing means for impressing thereon a high-frequency current, and a translating device, and means mounted on said cabinet in open view for giving instant visual warning upon the flow of destructive abnormal current, said means being protected from accidental contact.

2. A high-frequency cabinet for therapeutical work and the like, containing circuit-wires leading from a suitable source of current, a high-frequency high-potential disruptive discharge mechanism within said cabinet to operate in connection with said circuit, and an auxiliary detonator in parallel with said mechanism at the high-frequency high-potential end of said circuit, for giving instant audible warning upon the flow of destructive abnormal current.

3. A high-frequency cabinet for therapeutical work and the like, containing circuit-wires leading from a suitable source of current, a high-frequency high-potential disruptive-discharge mechanism within said cabinet to operate in connection with said circuit, and means responsive to the flow of destructive abnormal current for generating instantly a volume of bad-smelling gas or smoke capable of immediately permeating the atmosphere to the distance usually occupied by the operator, for giving warning to said operator by the sense of smell, said gas-generating means being mounted in an exposed position on said cabinet whence the said gas can freely escape in large volumes for the purpose set forth.

4. A high-frequency device for therapeutical work and the like, comprising a cabinet, containing a transformer, a condenser, a spark-gap device, and a translating device, and an electric circuit connecting said apparatus for producing a high-frequency high-potential disruptive discharge, and an auxiliary spark-gap device mounted on the outside of said cabinet and connected across said circuit between said transformer and said translating device, said auxiliary device being normally

inactive but capable of instant operation upon the flow of abnormal current for giving warning to the operator for preventing damage to the transformer.

5. A case containing electrical apparatus and having an aperture therethrough, a non-inflammable insulating-plate secured thereto, a spark-gap device mounted on said plate, and overhanging protecting means for said spark-gap.

6. A spark-gap device, comprising a support of non-inflammable insulating material, opposite electrodes mounted flat against the top surface thereof, and overhanging protectors mounted directly on said electrodes for preventing accidental contact therewith while leaving the spark-gap exposed and visible.

7. A spark-gap device, comprising a support of non-inflammable insulating material, opposite electrodes mounted thereon, and protectors mounted on said electrodes projecting over the discharge-gap, said protectors being composed of odoriferous material becoming active in the presence of the arc from said electrodes.

8. A spark-gap device, having separated electrodes provided adjacent their discharge ends with material capable of emitting an odoriferous smoke when heated by the discharge, for giving warning to the operator.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

HOWARD JACKSON.

Witnesses:
GEO. H. MAXWELL,
EMILIO A. CARDARELLO.

No. 619,761. Patented Feb. 21, 1899.

T. B. KINRAIDE.

DYNAMO ELECTRIC MACHINE.

(Application filed Sept. 29, 1898.)

(No Model.) 2 Sheets—Sheet 1.

Fig: 1.

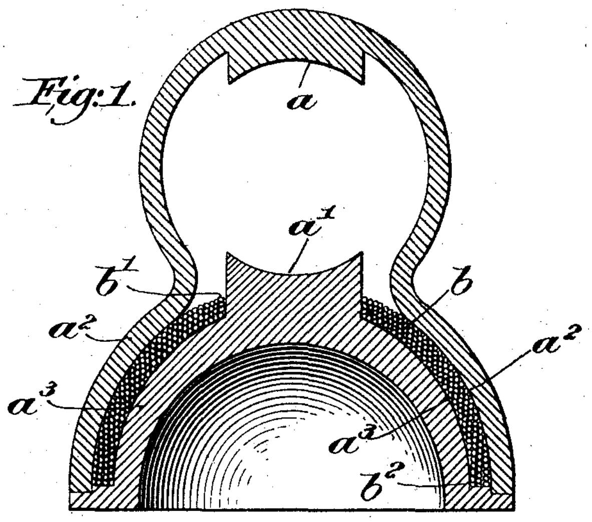
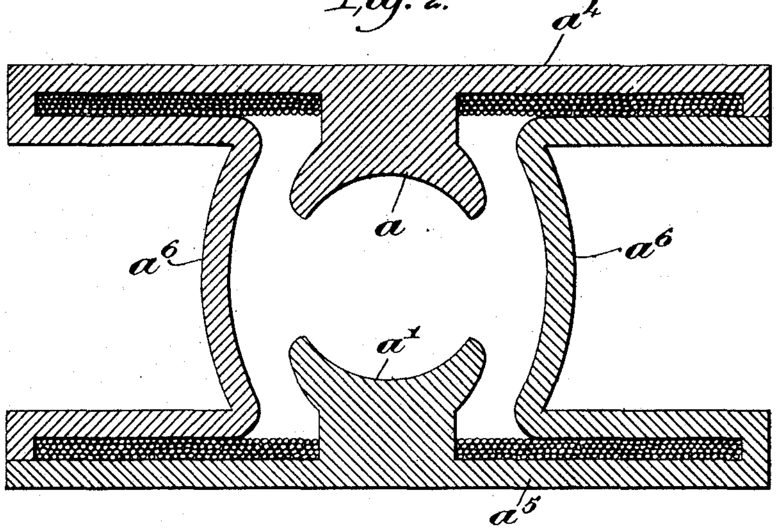


Fig: 2.



Witnesses,
Edward F. Allen.
James M. Urquhart.

Inventor,
Thomas B. Kinraide,
by Crosby Gregory.
attys.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 619,761. **Patented Feb. 21, 1899.**

T. B. KINRAIDE.

DYNAMO ELECTRIC MACHINE.

(Application filed Sept. 29, 1898.)

(No Model.) 2 Sheets—Sheet 2.

Fig: 3.

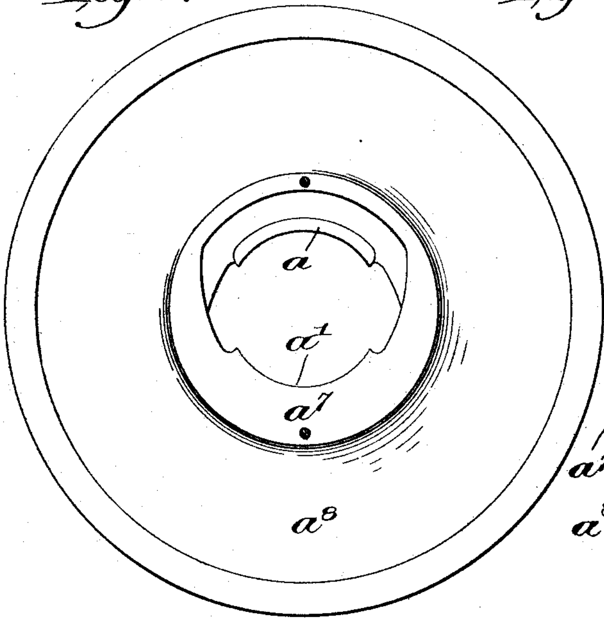


Fig: 4.

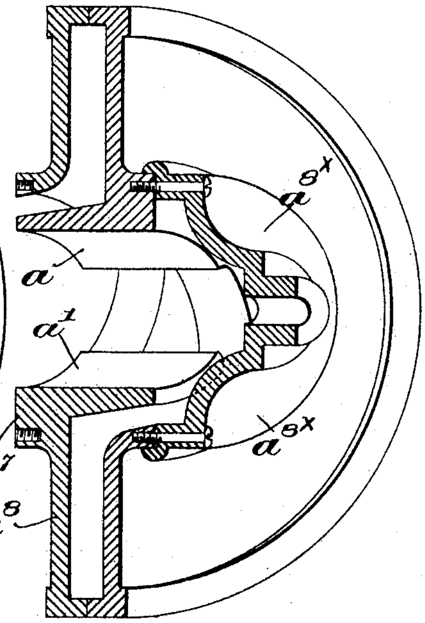


Fig: 5.

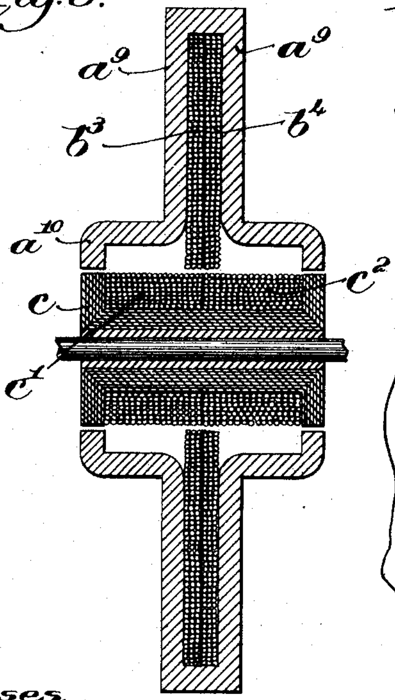
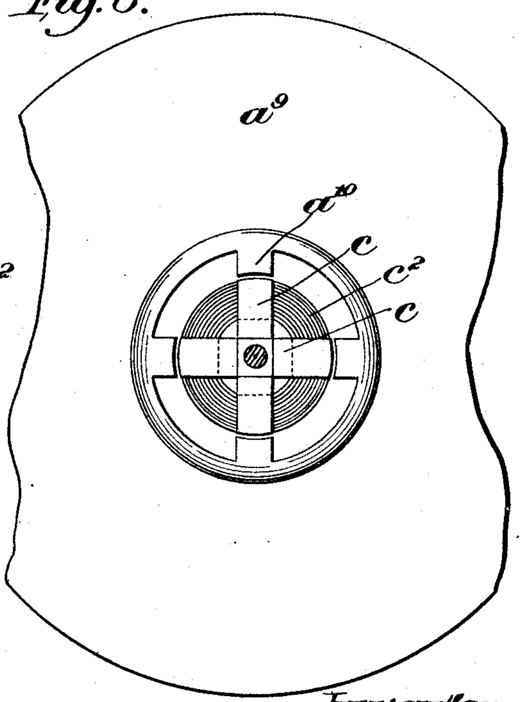


Fig: 6.



Witnesses,
Edward W. Allen.
James M. Urquhart.

Inventor,
Thomas B. Kinraide,
by Crosby Gregory.
Attys.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

UNITED STATES PATENT OFFICE.

THOMAS B. KINRAIDE, OF BOSTON, MASSACHUSETTS.

DYNAMO-ELECTRIC MACHINE.

SPECIFICATION forming part of Letters Patent No. 619,761, dated February 21, 1899.

Application filed September 29, 1898. Serial No. 692,159. (No model.)

To all whom it may concern:

Be it known that I, THOMAS B. KINRAIDE, of Boston, county of Suffolk, State of Massachusetts, have invented an Improvement in Electrical Apparatus, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

My invention is herein shown as applied to dynamos or motors, and it resides in the discovery or application of a new principle of winding, by which the lines of magnetic force are conveyed from a larger area to a smaller area for use, thereby producing polarization without any large extent of interior repulsion, such as is manifested in bar or cylindrical magnets or pole-pieces.

My invention might be termed a "focalizer" or "magnetic transformer" for the reason that it focalizes at the center all the lines of force from the successively longer turns toward the periphery. This gives quantitative effect and transforms the magnetic effect due to the lines of force from the longer turns at the periphery into magnetic potential at the center.

My invention will be more fully apprehended from the following description, taken in connection with the accompanying drawings, which are illustrative of different embodiments of my invention.

In the drawings, Figures 1 and 2 are central vertical sections of field-magnets constructed and wound to embody my invention. Fig. 3 is a view in side elevation, and Fig. 4 is a sectional perspective, of another form of field-magnet for a dynamo or motor embodying the same principles. Fig. 5 is a central vertical section, and Fig. 6 a side elevation, (partly broken,) of still another construction embodying the same invention, these figures showing the focalizer-field with extension-poles.

In Fig. 1 I have shown a field-magnet having two opposite pole-pieces a a', which, it will be understood, coöperate with an armature, which, however, is not shown, inasmuch as it does not constitute part of my present invention, my invention relating to the form and arrangement of the field-winding. The field-winding is indicated at b, where it will be seen that instead of being wound around the pole-piece in the form of a cylinder, which would be the usual winding, it is wound with progressively longer coils or turns, the shortest turns being at b' and increasing in length from that point to the outer or peripheral turns at b^2. Preferably the winding is very thin, in order that it may have direct action upon an extended area of the magnetic-field material, and I have herein shown the respective poles as energized from the opposite parallel surfaces a^2 a^3, thereby producing a motor or generator of the iron-clad type.

In Fig. 2 the pole-pieces a a' are at the center of disks a^4 a^5, connected at a^6 to constitute virtually one magnet.

Figs. 3 and 4 also show disk-shaped fields in which the pole-pieces a a' project in opposite directions from the hubs a^7 of similar castings a^8, the latter preferably having extensions $a^{8\times}$ thereof to constitute journal-bearings for the armature-shaft. (Not shown.)

Figs. 5 and 6 show a four-pole alternator having a split winding made up of the two parts b^3 b^4, which act on the disk-shaped field-magnets a^9 the same as in the other figures, the difference being, however, that the pole-pieces a^{10} are spread apart or extended, an armature being shown in position having stampings in the form of flat oblong strips of sheet metal c, bent at right angles opposite the pole-pieces and containing armature-windings c' c^2, which may or may not rotate with the armature, as may be preferred. This form of winding focalizes the magnetic lines to the best advantage and produces a quantitative effect at the pole-piece at the center.

One advantage of my new system or manner of winding is that much less winding is necessary for giving a practically-saturated pole-piece, and, moreover, the polarization of the lines of magnetic force takes place in the most natural manner without interior repulsion or pressure except at the place of use where required, and the lines of force are not wasted and dissipated. Their natural and normal outlet or direction of movement in or on the iron is toward the pole-piece at the center, where the polarization is desired. Also by having the winding spread out in thin layers, as shown especially in Figs. 1 and 2, there is a minimum conflict of lines of force in the windings themselves, there being merely enough thickness of winding over the surface of the iron to generate just the number of lines of force which can be accommodated by the iron.

By this system of winding the field offers less resistance to the flow of the energizing-current, the strength of the field at the periphery being almost *nil*, while at the center the concentration gives great strength, and on account of this low resistance I am enabled to obtain a much higher degree of saturation in the coil of the armature, and in consequence much greater efficiency from the machine.

By spreading the pole-pieces, as in Fig. 5, I am enabled to employ an armature or secondary winding of very many turns and small diameter, which produces high voltage.

I have chosen for illustration in explaining my invention castings adapted to dynamos or motors; but it will be understood that my invention is not restricted in this respect, but may be used for transformers of various descriptions and, indeed, for a wide range of electrical work, and I intend herein to claim the same broadly.

Having described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. In an electrical apparatus, an electromagnet for producing a magnetic field, and means for polarizing or converging the lines of magnetic force of said magnet from a large area thereof to a smaller area or pole, said means including a winding spread out coextensively with said large area and immediately adjacent to the surface of said magnet, substantially as and for the purpose set forth.

2. In an electrical apparatus, an electromagnet having its center of polarization substantially coincident with the mechanical center of the magnet, said magnet extending therefrom in a relatively thin body of constantly-increasing circumferential area from said center, and a relatively thin winding for said magnet, said winding having its turns constantly longer as they recede from said center of polarization, substantially as described.

3. In an electrical apparatus, coöperating magnets having central pole-pieces or places of polarization, said magnets each extending laterally in divergent directions from their respective regions of polarization, and windings for said magnets, said windings proceeding from said central pole-pieces outwardly along the surfaces of said radiating parts of the magnets in turns longer as they recede from the said pole-pieces, and said magnets inclosing their said windings between them, substantially as described.

4. In an electrical apparatus, coöperating magnets having central pole-pieces or places of polarization, said magnets each extending laterally in divergent directions from their respective regions of polarization, and windings for said magnets, said windings proceeding from said central pole-pieces outwardly along the surfaces of said radiating parts of the magnets in turns longer as they recede from the said pole-pieces, and said magnets inclosing their said windings between them, the said pole-pieces being spread apart, and an armature to coöperate with said pole-pieces, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

THOMAS B. KINRAIDE.

Witnesses:
GEO. H. MAXWELL,
ALEXANDER C. PROUDFIT.

No. 607,177. Patented July 12, 1898.

T. B. KINRAIDE.

ELECTRIC BREAK AND INDUCTION APPARATUS.

(Application filed July 26, 1897.)

(No Model.) 2 Sheets—Sheet 1.

Fig. 1.

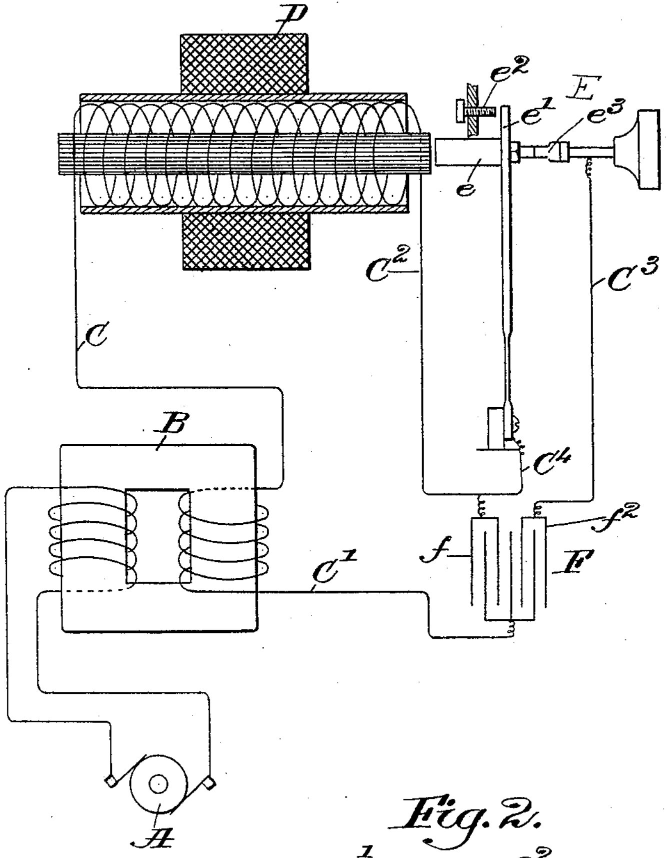


Fig. 2.

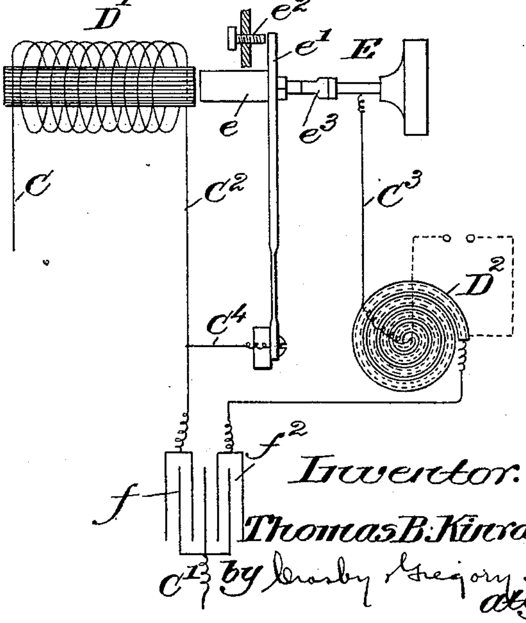
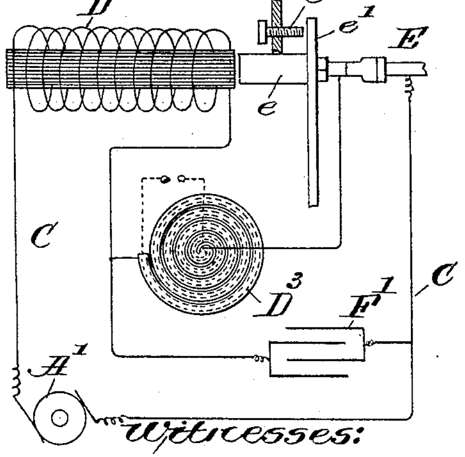


Fig. 2.a



Witnesses:
A.C. Harmon
Thomas J. Drummond

Inventor.
Thomas B. Kinraide
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THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 607,177. Patented July 12, 1898.

T. B. KINRAIDE.

ELECTRIC BREAK AND INDUCTION APPARATUS.

(Application filed July 26, 1897.)

(No Model.) 2 Sheets—Sheet 2.

Fig. 6.

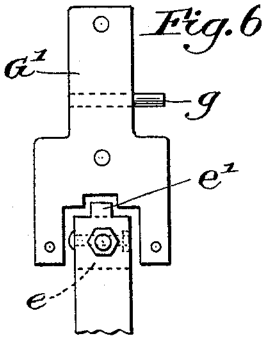


Fig. 4.

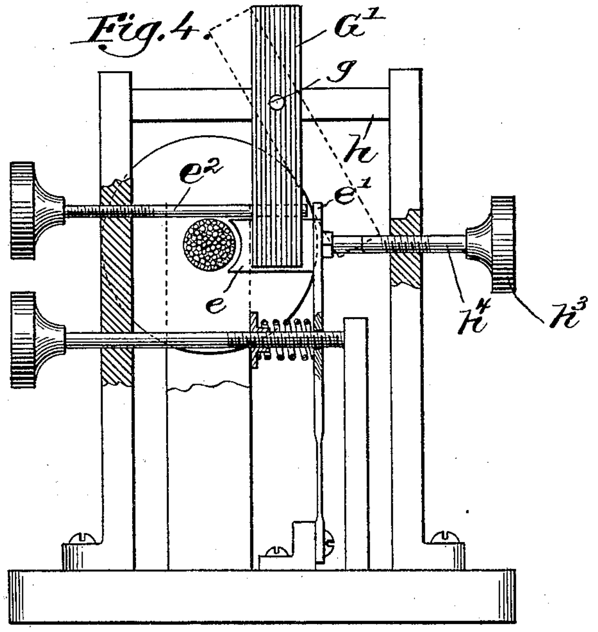


Fig. 8.

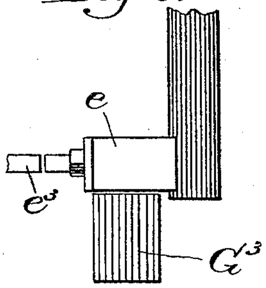


Fig. 3.

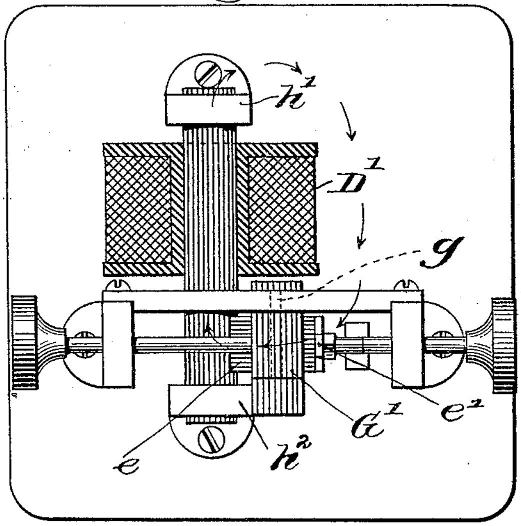


Fig. 7.

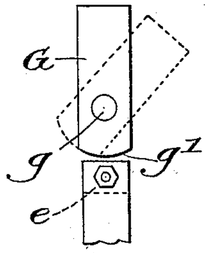
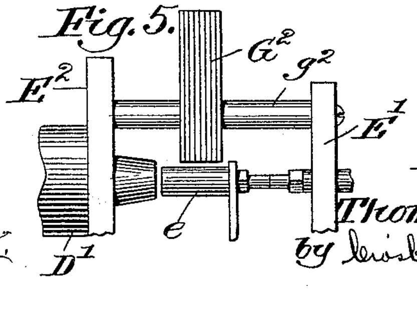


Fig. 5.



Witnesses:
A.C. Harmon.
Thomas J. Drummond.

Inventor:
Thomas B. Kinraide.
by Crosby & Gregory attys.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

UNITED STATES PATENT OFFICE.

THOMAS B. KINRAIDE, OF BOSTON, MASSACHUSETTS.

ELECTRIC BREAK AND INDUCTION APPARATUS.

SPECIFICATION forming part of Letters Patent No. 607,177, dated July 12, 1898.

Application filed July 26, 1897. Serial No. 645,880. (No model.)

To all whom it may concern:

Be it known that I, THOMAS B. KINRAIDE, of Boston, in the county of Suffolk and State of Massachusetts, have invented an Improvement in High-Speed Break and Induction Apparatus, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

My invention has for its object the provision of an improved break, particularly intended for use with induction-coils, and an improved means and method of operating the same.

In certain classes of electrical work it is of peculiar advantage to have the fluctuations of the inducing-current dropped with extreme suddenness from their maximum, so that instead of the usual sinusoidal curve the curve will present a series of gradual rises followed by abrupt drops in substantially vertical lines.

The details of my invention will be pointed out in the following description, reference being had to the accompanying drawings, and the invention will be more fully defined in the appended claims, also forming a part of this specification.

Figure 1 is a diagrammatic view of apparatus arranged in accordance with my invention. Figs. 2 and 2^a are similar views, respectively, of slightly-modified arrangements. Fig. 3 is a plan view of the preferred form of apparatus embodying my invention. Fig. 4 is a view in front elevation of the apparatus shown in Fig. 3, parts partly in section and partly broken away to expose the operating parts. Fig. 5 is a view of my "collector" applied to a well-known type of break. Figs. 6 and 7 are views of two forms of collector, that in Fig. 6 being of the preferred form shown in Figs. 3 and 4. Fig. 8 is a fragmentary detail in top plan, showing a rigid collector placed on the side of the hammer opposite the coil.

My invention is intended for use either with alternating or direct currents.

Referring to Fig. 1, it will be understood that A designates a usual alternating-electric-current dynamo. This is connected to a usual transformer B, and in the circuit C C′ thereof are included the induction-coil D, break E, and condenser F of my invention, which I will now explain. The induction-coil may be of any suitable kind desired. The primary of the latter instead of connecting directly to the main circuit at C′ is connected with one part f of a double condenser at C^2, the other part f^2 of said condenser having connection at C^3 with the break and through the latter with the part f thereof at C^4, the condenser F being connected at its opposite end to the main wire C′.

The principle of operation of my improved apparatus so far as explained may be briefly stated thus: When the break is closed, the full current passes through the induction-coil by reason of the fact that the condenser has both its parts f f^2 in closed circuit therewith, the part f being always in closed circuit, as described, and the part f^2 being in closed circuit through the connection C^3, the closed break, and the connection C^4. The core of the induction-coil is strongly magnetized upon the passage of this full current and immediately withdraws the hammer of the break from its anvil, so as to interrupt the current and thereby cut off that portion of it depending upon the part f^2 of the condenser. This causes at once a sudden drop in the inductive action of the coil.

It will be noted that the hammer e of the break is provided with means positively to limit its movement, said means being shown in the form of a projection e' coöperating with a stop e^2, preferably adjustable. (Indicated in Fig. 1 and shown more in detail in the preferred form of my apparatus shown in Figs. 3 and 4.) By reason of this stop the length of the spark-gap between the hammer e and its anvil e^3 is positively controlled, so that the time period of the interruptions may be regulated to the requirements for throwing the charged condenser f^2 into the circuit for discharging it at the proper moment to accelerate the inductive action of the primary.

In the figures last mentioned I show the preferred form of my break, in which it will be seen that the anvil is not at the end of the core, as is usual, but is at the side thereof, the core projecting from the coil sufficiently to enable this to be done. The reason for this is that I have found that by placing the hammer thus directly in the field of the greatest number of lines of force the action of the apparatus is very materially improved, and in order to increase the frequency and to get rid of the heating thereof, so that the break can be extremely rapid, I have made the several parts thereof laminated, the core being preferably composed of a plurality of wires and the anvil of a number of plates secured together, although any other means of lamination is within my invention.

A further feature of my invention resides in providing a collector G for the lines of force to direct them upon the hammer, thereby enabling me to use a much smaller hammer than would otherwise be possible for the same effect.

When formed as illustrated in Figs. 3 and 4, the collector consists of a body of metal G', preferably soft steel or iron and preferably laminated, placed within the field of force of the coil and immediately adjacent the hammer, thereby presenting to the hammer a field of strong magnetic intensity, so that it is equivalent to making the hammer much larger, at the same time permitting a much smaller moving part than usual. Preferably this collector will be movable relatively to the hammer, so that its effect on the latter may be varied.

In Fig. 7 I have shown the collector G as pivoted at g and as having its lower end curved at g' adjacent the hammer e. By this provision it will be seen that the amount of current delivered through the break is readily controlled, inasmuch as the collector tends to gather in the lines of force and direct them to the hammer, so that if the collector is in the full-line position, Fig. 7, the greatest intensity will result, whereas if the collector is in its dotted-line position a less intensity will result, and this may be varied according to the position into which the collector is swung. The resultant effect upon the hammer is that it has an active or sluggish movement, according to the position of the collector.

When the collector is swung entirely away from the hammer, or in case it is omitted entirely, the tendency of the hammer is to lag or hang to the anvil as it is drawn away, whereas with the collector in its full-line position, as shown, the action of the break is short and quick.

In Fig. 5 I have shown one form of my collector as applied to a break having its hammer at the end of the core, the collector G^2 being therein shown as pivoted on a connecting or brace rod g^2 at the upper end of the posts E' E^2.

In Figs. 3, 4, and 6 I have shown the collector having a bifurcated end in order to encompass the hammer. In this case it will be understood that the regulator is composed of a plurality of pieces of metal stamped out and bound together to constitute its laminated body.

The configuration and position of the collector may be otherwise changed to include a greater or a fewer number of the lines of force or, indeed, the entire field, according to the effect it is desired to produce upon the hammer, one example being illustrated in Fig. 8, in which the collector G^3 is shown as mounted at the side of the hammer opposite the coil. With this construction whenever by the tearing off of small pieces of metal from the contact-points the break-gap is partially short-circuited when open the rapidly-increasing lines of force are so concentrated by the collector upon the hammer as to drag the latter sidewise toward the collector, thus overcoming the short circuit by shearing apart the fused particles and separating the points, the hammer then resuming its normal vibration.

In Fig. 2 I have shown another means of connecting the parts, D' indicating a solenoid for the purpose of drawing back the hammer of the break E, and an induction-coil being shown as interposed between the break and the part f^2 of the condenser, a flat coil, such as I have shown in my application Serial No. 636,293, being herein shown as preferred for this purpose, D^2 indicating the primary, and the secondary being shown by dotted lines. It will be understood that when the break is interrupted with a short spark-gap an extremely rapid oscillation takes place between the two parts f f^2 of the condenser F, and this effects an extremely rapid rise and fall of potential in the coil D^2, thereby producing a very efficient inductive action.

In Fig. 2^a I have shown an embodiment of my invention arranged for use with a direct current. In this construction the solenoid D' operates the automatic break E, the latter having a stop e^2, as before and for the same purpose. When the attraction of the solenoid opens the break, the condenser F' is rapidly charged and discharged with very high potential from the self-induction of the solenoid D' through the coil D^3, then in series circuit with the condenser. By this means I am enabled to use a direct current with a high-efficiency induction apparatus operated by or in connection with a vibrator-break.

My object in general is to increase the efficiency of induction apparatus or oscillators used in connection with breaks of the vibrator class.

The above-described improvements of the break or interrupter give it much sharper and improved action as well as increased speed, and the method and means of operating an induction apparatus therewith or therefrom increase the extent or range of the fluctuations, giving the sharp drop from the top of the wave before mentioned, together with increased rapidity. The two parts f f^2 of the condenser may be separated provided the part f is in the closed circuit and the part f^2 is in an interrupted circuit, as before explained. Moreover, my invention enables the operator readily to control the apparatus and the character of the inductive action.

The invention is not restricted in anywise to the embodiments herein presented, as various changes are within the scope thereof, and it is not otherwise limited than as defined in the following claims.

Having described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. The combination with an electric break having an electromagnet, an anvil, and a vibrating hammer, of a collector to concentrate the lines of magnetic influence on said hammer, substantially as described.

2. The combination with an electric break having an electromagnet, an anvil, and a vibrating hammer, of a collector to concentrate the lines of magnetic influence on said hammer, and means to vary the position of said collector relatively to said hammer, substantially as described.

3. The combination with an electric break, having an electromagnet, an anvil, and a vibrating hammer, of means to shear or drag sidewise the hammer from the anvil whenever the break-gap between the hammer and anvil is partially short-circuited by the fusing or clinging of the metal at the contact-points, substantially as described.

4. An electric break of the vibrator class, provided with a hammer composed of laminated material, substantially as described.

5. In an electric break, a core, hammer, and collector, to concentrate the lines of magnetic influence on the hammer, said collector being composed of laminated material, substantially as described.

6. The combination with an electric break, having an anvil and a vibrating hammer, of a positive stop to limit and positively stop the movement of the latter from the anvil, substantially as described.

7. The combination with an electric break, having an anvil and a vibrating hammer, of a positive stop to limit and positively stop the movement of the latter from the anvil, and means to adjust said stop, substantially as described.

8. The combination with a break, having an anvil, a vibrating hammer, and a positive stop for the latter, of a condenser interrupted by said break, and an induction-coil in series circuit therewith, substantially as described.

9. The combination with a break, having an anvil, and a vibrating hammer, of an electric circuit operating the same and interrupted thereby, an induction apparatus in said circuit, and a condenser having independent connections to said anvil and said hammer, substantially as described.

10. The combination with an electric circuit, including an induction apparatus, and an interrupter, of a double condenser also in said circuit, said induction apparatus having continuous connection with one part of said condenser and interrupted connection with the other part of the condenser, substantially as described.

11. The combination with an electric circuit, including an induction apparatus, and an interrupter including a hammer and anvil, of a double condenser also in said circuit, said induction apparatus having continuous connection with one part of said condenser and interrupted connection with the other part of the condenser, and means to regulate the movement of said hammer so as to bring the discharge of the said interrupted part of said condenser into synchronism with the period of said circuit, substantially as described.

12. The herein-described method of operating an induction apparatus in a system including said induction apparatus, an interrupter, condenser, and source of electric energy, said method consisting of energizing the induction apparatus from said source of energy in connection with said condenser, and when the wave is at its extreme fluctuation, cutting out the condenser, substantially as described.

13. The herein-described method of operating an induction apparatus in a system including said induction apparatus, an interrupter, condenser, and source of electric energy, said method consisting of energizing the induction apparatus from said source of energy in connection with said condenser, and when the wave is at its extreme fluctuation, cutting out the condenser the induction apparatus being then in direct circuit with the source of energy, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

THOMAS B. KINRAIDE.

Witnesses:
GEO. H. MAXWELL,
JOHN C. EDWARDS.

No. 607,176. Patented July 12, 1898.

T. B. KINRAIDE.

ELECTRIC BREAK FOR INDUCTION COILS.

(Application filed Feb. 26, 1897.)

(No Model.)

Fig. 1.

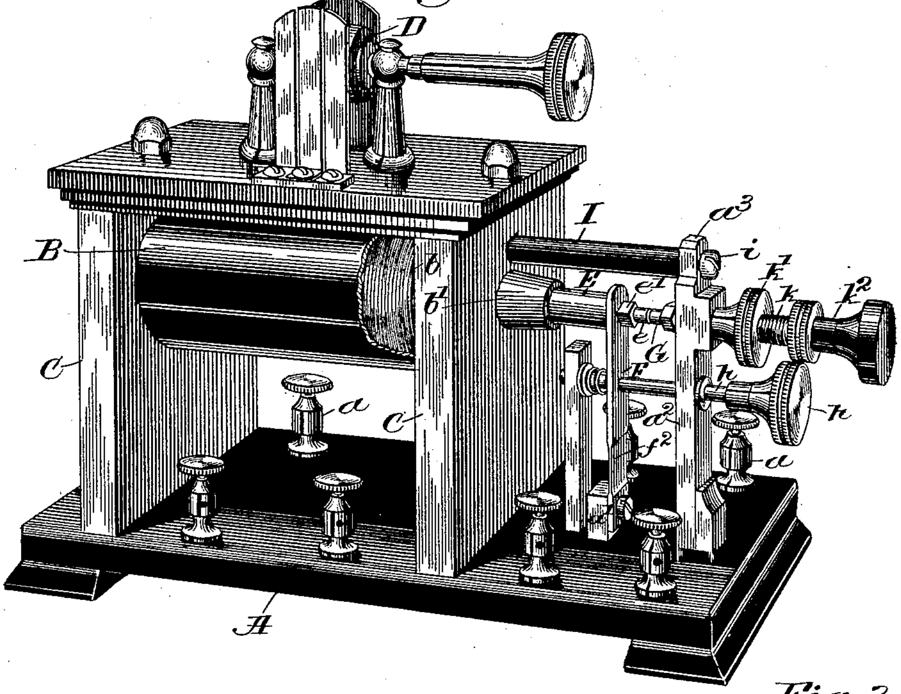


Fig. 3.

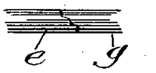


Fig. 2.

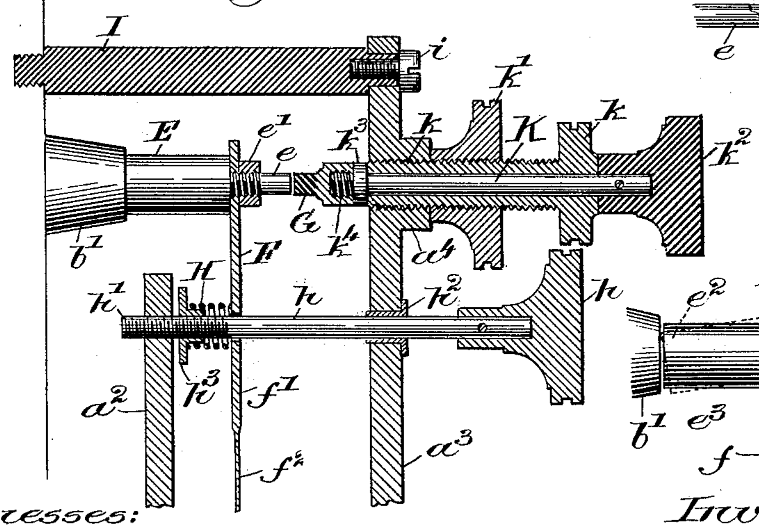
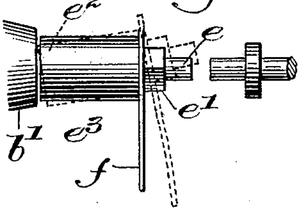


Fig. 4.



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THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

UNITED STATES PATENT OFFICE.

THOMAS B. KINRAIDE, OF BOSTON, MASSACHUSETTS.

ELECTRIC BREAK FOR INDUCTION-COILS.

SPECIFICATION forming part of Letters Patent No. 607,176, dated July 12, 1898.

Application filed February 26, 1897. Serial No. 626,173. (No model.)

To all whom it may concern:

Be it known that I, THOMAS B. KINRAIDE, of Boston, county of Suffolk, State of Massachusetts, have invented an Improvement in Electric Breaks for Induction-Coils, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

It is the object of my invention to provide an improved automatic break or interrupter for electric currents, my invention being particularly adapted for use in interrupting the primary current of induction-coils in connection with X-ray and kindred apparatus.

My invention secures high speed and accuracy of break, the successive breaks being rendered similar and synchronous, provides uniformity of wear of the make-and-break contacts, cures the irregularity and unsteadiness of the current hitherto so objectionable, and gives uniform action of both current and apparatus under different resistances, besides simplifying and prolonging the life of the instrument. As heretofore constructed these instruments have had a break-hammer carried on the free end of an ordinary leaf-spring vibrating between the core end of an electromagnet and a small contact or anvil, the latter being mounted on the end of an adjusting-screw in the free end of a post or standard. One serious drawback to these instruments has been that the speed of interruption—*i. e.*, the speed of the vibrations of the hammer—has been quite limited and there has been an unevenness of break. I have found that these faults are due to a compound vibration of the instrument, which tends to hasten some of the breaks and to retard others, and I have further found that this "compound vibration," as I call it, may be obviated and that high speed may be attained and accurate breaks secured by providing an absolutely rigid and unyielding post or standard. As a result of this feature of my invention the objectionable inaccuracy and unevenness of the breaks or interruptions disappear and a nicety of adjustment and compensation is feasible, which would not otherwise be possible. A further objection to the present old style of instrument above mentioned is that as the tension of the spring-vibrator is increased to vary the electrical resistance of the break the sparking of the instrument is increased, the current being also otherwise rendered irregular and uncertain, and I have discovered that this is due to the fact that in the adjustment of the vibrator the hammer is thrown more or less out of alinement with the core end and anvil. It is therefore one chief feature of my invention to provide means to maintain the hammer in proper accurate alinement with its core and anvil. Again, irregularity and unsteadiness of current are due to the uneven wear of the contacting surfaces of the hammer and anvil, the intense heat of the constant arcing serving to fuse and batter down the said surfaces unevenly; and therefore I have mounted one of these surfaces on a rotatable spindle, so that the irregularities thereof may be automatically removed or obviated by rotating it as the hammer is vibrated.

Various other advantages and features of improvement of my invention, as well as the details of construction thereof, will appear in the course of the following description, reference being had to the accompanying drawings, illustrative of the preferred embodiment thereof.

In the drawings, Figure 1 is a perspective view of an automatic break or interrupter provided with improvements of my present invention. Fig. 2 is an enlarged central vertical section of the right-hand end of Fig. 1, showing the details of construction thereof more fully. Fig. 3 is a view showing how the contacting surfaces fuse into one another in instruments as heretofore constructed. Fig. 4 illustrates one of the objectionable features of the old-style instruments.

On a suitable base A, provided with the requisite complement of binding-posts *a*, is mounted in a jacket B a usual electromagnet *b* in a frame C, the latter also carrying a switch D, all of usual or preferred construction.

A hammer E, carried by a vibrator F, reciprocates between the core end *b'* and an anvil G, being shown as provided with a reduced end *e*, screw-threaded and held rigidly on the vibrator by a check-nut *e'*. Heretofore this vibrator has been a leaf-spring *f*, as indicated in Fig. 4, this spring being deflected more or less to the right as it is desired to increase the electrical resistance offered by the hammer, the result being as shown in exaggerated form in Fig. 4, where it appears that the spring *f*, when deflected to its dotted position, inevitably upsets the hammer, so that the latter, when attracted to the core b', strikes the latter with its upper edge e^2 only, thereby increasing the resistance entirely out of proportion to that intended and tending to burn or fuse down the small point of contact e^2, also leaving a spark-gap e^3, tending to ruin the hammer. The disastrous effects at the opposite end of the hammer are of the same sort, the difference being that, the contact-surfaces being smaller and composed of platinum, it is still more serious.

I make the vibrator F rigid and unyielding for most of its length, as shown at f', a short resilient section f^2 being preferably provided at its lower end next to the stud a', to which it is shown as fastened, and the necessary tension being secured by means of an auxiliary or tension spring H, carried on the shank of an adjusting-screw *h*, working at its threaded end h' in a post a^2 and journaled at h^2 in the standard a^3. An adjustable thumb-nut h^3 receives one end of the spring H, the opposite end bearing against the vibrator F, which rides loosely over the screw-rod *h*. This is merely a preferred form of mechanism for accomplishing my object. By turning the screw *h* to the right or left the spring H is correspondingly relaxed or tightened, thereby tending to move the vibrator F bodily forward to a greater or less extent to increase the number of amperes or quantity of current transmitted, and it will be noted that the hammer does not depend on the vibrator for its tension or resistance, but rather on the independent spring H, which bears centrally forward against the vibrator, the yielding section f^2 flexing readily enough to permit the required movement forward of the rigid portion f'.

The interruptions of the electric current are required to be so frequent for efficient work that the very slightest disturbance is exceedingly objectionable. The breaks should produce a note of two hundred and fifty vibrations per second at least, and these should be even or accurate and synchronous. Accordingly I have rendered the standard a^3 absolutely rigid and non-vibrant, finding as a result that the accuracy of break which is sought is thereby attained and that the speed or note of vibration is raised. I prefer to render the standard thus rigid by interposing a bar or brace I of insulating material between the frame C and standard a^3, this bar being shown as screwed into the frame and held rigid in the standard by a set-screw *i*. Various other means for the purpose may be employed, the requirement being to prevent the standard, and hence the anvil, from being responsive to the vibrations of the hammer, and thereby occasioning a compound or confused vibration or interruption of the current.

Referring now to the third feature of my invention, it will be understood that as the hammer end *e* is pulled away from the anvil G an arc is formed which fuses a slight portion of the opposing surfaces, and as the breaks are rapid these surfaces, although platinum, are quickly rendered uneven, so that in the old construction, in which the anvil was carried fixedly on the end of its adjusting-screw, the surfaces would fuse into each other disastrously, as shown in Fig. 3, where *e* designates the hammer and *g* the anvil. Accordingly I provide means to relatively rotate the meeting surfaces of the anvil and hammer independently of the rotations due to the adjustments of said parts, the said means being herein shown as preferably consisting of a freely-rotatable spindle K, centrally mounted in a hollow adjusting-screw *k*, having threaded engagement with an extended bearing a^4 in the standard a^3, being fixed in its adjustments by a check-nut k'. The spindle K is rotated by a thumb-wheel k^2, pinned on its outer end, and is held against longitudinal movement by a collar k^3, fixed near its inner end to abut against the inner end of the screw-carrier *k*. The spindle is threaded at k^4 to receive the anvil G, the latter being shown in the form of a threaded cap provided with the desired platinum contact, the platinum being soldered thereon, as indicated in heavy section-lines, Fig. 2. The collar k^3 and anvil are made of a size to permit them to be withdrawn, together with the adjusting-screw *k*, as the latter is screwed back out of the standard a^3.

In practice the operator will slightly rotate the anvil occasionally, so as to change its relative position to the hammer, thereby changing the fused and fusing places and maintaining the surfaces even and comparatively smooth. The result is that the points of contact wear uniformly and the irregularities and unsteadiness of current produced by the old construction are cured.

It is understood that as the platinum points wear and fuse away the anvil is nicely adjusted forward by its screw-carrier *k* to compensate therefor. Under the old construction, however, where the anvil *g* was fixed on the adjusting-screw, the surfaces would wear unevenly, as explained, and as shown in Fig. 3, and then when it became necessary to adjust the anvil forward it would be impossible, because it would be found that the surfaces had become more or less interlocked, thereby preventing any relative rotation thereof, the result being that the apparatus was rendered useless until the anvil had been removed and the contacting surfaces carefully filed down accurately, not only entailing loss of time but loss of the platinum.

According to my invention the adjusting

movement is entirely independent of any rotation of the anvil.

While I have endeavored above to describe the details of the mechanism in which I have embodied my invention, I wish it distinctly understood that these are not of the essence of my invention, being merely preferred embodiments thereof, and that many other means may be employed within the spirit and scope of my invention.

Having fully described my invention, what I claim, and desire to secure by Letters Patent, is—

1. A high-speed break, comprising a coil and its core, an anvil in electric circuit with said coil, a standard supporting the anvil, and a vibrating hammer in and interrupting said circuit and vibrating between said core and anvil, combined with means substantially as described to prevent compound vibrations of said anvil and hammer, for the purpose set forth.

2. In a high-speed break, the combination with a vibrating hammer, and an anvil, of a standard supporting said anvil, and a brace rigidly secured between said standard and the frame of the break, substantially as described.

3. In a high-speed break, having a hammer vibrating between a core end and an anvil, means to vary the vibrating resistance of said hammer, and means to maintain said hammer in approximately unvarying end alinement with said core end and anvil, substantially as described.

4. In a high-speed break, a hammer, a vibrator supporting the same, and an adjustable tension device to vary the resistance of said hammer, said vibrator having an extended rigid portion extending from said hammer, substantially as described.

5. In a high-speed break, a hammer, a vibrator supporting the same, and an adjustable tension device to vary the resistance of said hammer, said vibrator having an extended rigid portion extending from said hammer and being provided at its opposite end with means to permit said rigid portion to be deflected slightly, substantially as described.

6. In a high-speed break, the combination with a hammer, of a rigid vibrator, means permitting the latter to move laterally, a tension-spring engaging said rigid vibrator, and means to adjust said spring, substantially as described.

7. In an electric break, having a hammer vibrating against an anvil, and means to adjust the latter, means to rotate said anvil independently of its said adjustment, substantially as described.

8. In an electric break, the combination with a hammer, its anvil, and a hollow adjusting-screw for the latter, of a spindle carrying said anvil and rotatably mounted therein, substantially as described.

9. The herein-described anvil, the same consisting of an interiorly-threaded cap, and a centrally-extended platinum contact integrally secured thereon, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

THOMAS B. KINRAIDE.

Witnesses:
GEO. H. MAXWELL,
FREDERICK L. EMERY.

No. 774,758. PATENTED NOV. 15, 1904.

T. B. KINRAIDE.

ELECTRIC SPARK GAP.

APPLICATION FILED MAY 25, 1904.

NO MODEL.

Fig. 1.

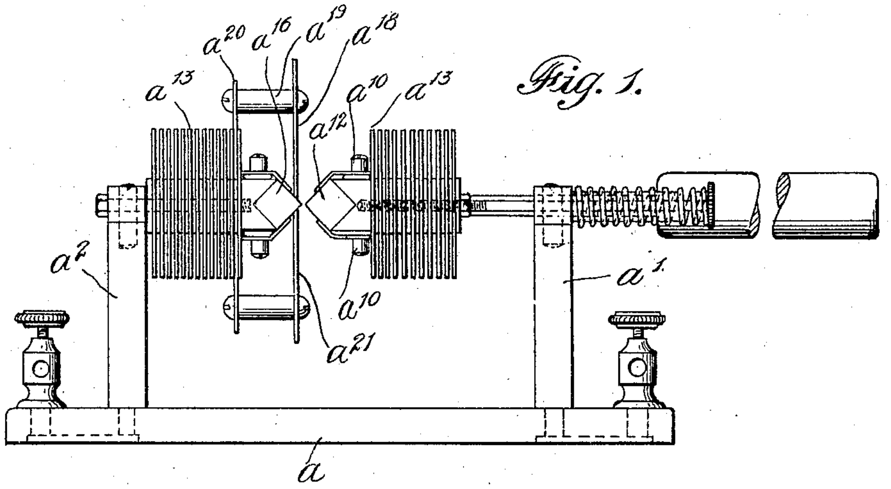


Fig 2.

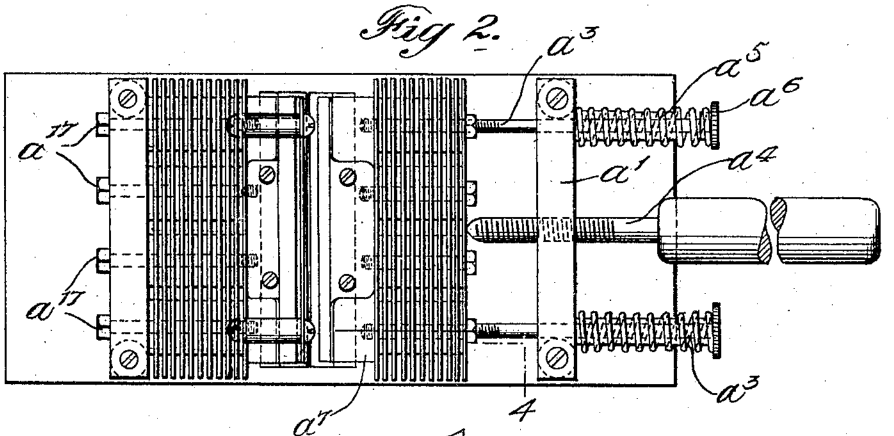


Fig. 3.

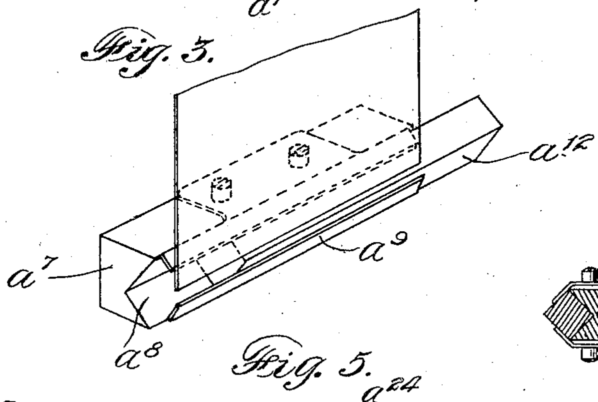


Fig. 4.

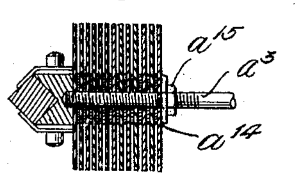
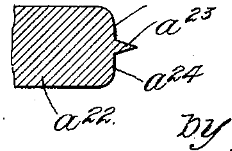


Fig. 5.



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Robert Ringrose.

Inventor,
Thomas B. Kinraide,
by Geo. H. Maxwell
Attorney.

PHOTO-LITHOGRAPHED BY SACKETT & WILHELMS LITHO. & PTG. CO. NEW YORK.

No. 774,758. Patented November 15, 1904.

UNITED STATES PATENT OFFICE.

THOMAS B. KINRAIDE, OF BOSTON, MASSACHUSETTS.

ELECTRIC SPARK-GAP.

SPECIFICATION forming part of Letters Patent No. 774,758, dated November 15, 1904.

Application filed May 25, 1904. Serial No. 209,686. (No model.)

To all whom it may concern:

Be it known that I, THOMAS B. KINRAIDE, a citizen of the United States, and a resident of Boston, in the Commonwealth of Massachusetts, have invented an Improvement in Electric Spark-Gaps, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

My invention relates to spark-gaps intended particularly for high-frequency apparatus where great strain and constant action with a high-voltage current is required, my object being to provide a spark-gap capable of continuous service with uniform and economical action. One of the main difficulties encountered in this class of apparatus is that the heating effects are apt to cause a short circuit, thereby destroying the sparking effects and rendering them irregular in their action by tending to produce a continuous arc, due partly to the heated condition of the metal and partly to the heated air, which forms a good conductor between the two electrodes, and also the intense heating of the electrodes, especially at their points, tends rapidly to destroy them. Moreover, when used with an alternating current a point spark-gap is apt to be quite irregular and unsteady in its operation. Also the oxidizing of the metal causes serious interference with the continuous and proper operation of the usual spark-gap. My invention is to obviate all these disadvantages, as will be more fully pointed out in the course of the following description, where I have set forth in detail a preferred mechanical embodiment of my invention, and the latter will be more particularly defined in the appended claims, forming a part of this specification.

In the drawings, Figure 1 represents one embodiment of my invention in side elevation. Fig. 2 is a top plan view thereof. Fig. 3 is a fragmentary detail in perspective, showing one of the percussion-plates in place and illustrating the removable character of the electrodes. Fig. 4 is a transverse sectional view taken on the dotted line 4, Fig. 2. Fig. 5 is a transverse sectional view of a modified form of discharge-electrode.

Mounted on a suitable base a are opposite uprights or supporting-standards a' a^2 for supporting the electrodes which constitute the apparatus the standard a' supporting slide-rods a^3 and an adjusting-screw a^4, operating in opposition to springs a^5, held between the support a' and headed ends a^6, provided on the slide-rods a^3. The rods a^3 support at their forward ends an electrode-carrier a^7, herein shown (see more particularly Fig. 3) as having a slideway a^8 at its forward side and provided with overhanging retaining-clips a^9, removably secured to the carrier a^7 by set-screws a^{10}. Said clips a^9 and way a^8 constitute a receiving-passage and holder for a removable electrode a^{12}. At the rear of the electrode-carrier a^7 I mount a series of vertically-extending heat-separators a^{13}, spaced apart by any suitable means, herein shown as themselves threaded upon the slide-rods a^3 and held apart by intervening washers a^{14} and clamped in immovable relation by nuts a^{15}. Opposite the electrode a^{12} is a similar electrode a^{16}, removably retained in a similar holder, composed of clips and a carrier, the same as already described. The latter is supported on rods a^{17}, rigidly held in the rear standard or support a^2 and carrying separator-plates a^{13}, as in the case of the opposite electrode.

The electrodes proper or discharge-bars a^{12} are herein shown as square in cross-section, and the seats of the holders are correspondingly shaped, the purpose of this construction being to permit the parts a^{12} to be changed, one edge thereof being kept in use until worn away, and then the electrode is simply pulled out from its holder, given a quarter-turn, and inserted again with another corner or edge presented for active use. These removable parts a^{12} are preferably composed of hardened steel, so that the oxid whenever formed is at once burned off, whereas with copper and the baser metals a permanent film of non-conducting oxid is formed, which rapidly results in insulating the discharge-surface of the electrodes. A **V**-shaped edge gives the best results; but the bar may be varied from the triangular shape to cylindrical shape to suit different conditions.

Adjacent one of the electrodes herein shown for convenience of illustration (and preferably so constructed for use) is a percussion-plate a^{18}, rigidly connected by bolts a^{19} to brackets or supporting-arms a^{20}, extending from the outer pair of rods a^{17}. Also, preferably, a similar percussion-plate a^{21} is mounted in vertical alinement with plate a^{18} to coöperate with the electrode a^{16}, on the under side thereof. These plates a^{18} a^{21} engage or are arranged close to the electrode a^{16}, slightly back from the point or edge thereof. If desired, similar percussion-plates may be employed on both electrodes, although for usual purposes the arrangement shown is sufficient and even one of the plates will ordinarily suffice.

The foregoing construction taken as a whole results in giving a uniform continuous action, the separators a^{13} serving to separate the heat effect from the electric effect, it being borne in mind that there is always present a heat effect which invariably accompanies the electric discharge, and the object of the separator-plates a^{13} is to separate these two effects, thereby confining the spark-gap discharge as nearly as possible to the electric effect solely and shunting the heat effect or separating it as developed from the electric effect as the discharge takes place between the points at the discharge-gap. This results in permitting a continuous disruptive discharge effect. Taken alone, however, it does not give uniformity of action with an alternating current, and to secure this result I provide the percussion-plate, as I have found that the main reason for unsteady and defective action in this particular is due to the fact that the alternations of the current interfere with each other and produce a bombardment at the spark-gap, resulting in a decidedly irregular sparking. I have also discovered that this irregularity of action can be entirely prevented simply by placing a plate slightly back from the discharge-point, the result being that it permits both alternations to spark across the gap. The plate simply destroys the arcing which is otherwise produced by the alternation of the current, and thereby enables the discharge to take place naturally and also make a much freer path for the discharge, permitting longer sparking.

I prefer to make the percussion-plates of copper, although other materials may be used. In Fig. 5 I have shown a construction in which the percussion-plate is embodied with the electrode as nearly as possible, (although the result is inferior to that secured by the construction above explained,) said figure showing an electrode a^{22}, having a discharge edge or point a^{23}, and adjacent thereto a plane surface a^{24}, serving very much the same purpose as the plates a^{18} a^{21}. The discharge-point a^{23} maintains a positive condition and the plane surface a^{24} a negative condition, the former constituting a discharge element and the latter a receptive area and coöperating with the point a^{23} to receive the bombardment or percussion and counteract the arcing, as above explained.

In use the alternating current passes from one electrode to the other across the gap with the utmost freedom under all conditions of stress, and the construction above explained in detail results in a steady and uniform discharge, removing all strain on the condenser by making a perfectly free and easy path for the discharge.

Besides the features of construction to which I have already directed special attention I wish to direct attention to the fact that the preferred embodiment of my invention herein disclosed provides an edge discharge of considerable length, thereby securing to a large extent the advantages more fully explained in my Patent No. 623,318, dated April 18, 1899.

It will be understood that while I have endeavored herein to comply with the law requiring a complete description of the best embodiment of my invention I do not intend to limit all my claims thereto and wish it understood that various features of my invention are applicable to other relations and that many changes in form, arrangement, and combination of parts may be resorted to without departing from the spirit and scope of my invention. For example, the main features of my invention are applicable to a point discharge-gap, and so likewise various features herein shown may be omitted and yet leave a construction capable of producing superior results over the ordinary spark-gap. I consider the removable feature of the electrodes as of considerable importance, the holder being slightly yielding for maintaining perfect contact and yet permitting the instant removal of the electrodes for the purpose of rotating them so as to bring a new edge into active position or for the purpose of replacing them with entirely new electrodes. Also the copper separator-plates or means of separating the heat effect from the electric effect of the discharge is of importance, as it prevents the overheating of the discharge electrodes. In other words, this part of the invention provides what might be termed a "cool" discharge instead of a hot discharge rapidly tending to produce an arc and also the "percussion-plates," as I term them, for taking the bombardment and preventing the colliding or interference of the alternating current, thereby giving a smooth uniform discharge. All these novel features conspire together to produce a continuously even and steady discharge. Besides these leading features I have in some of my claims claimed various specific constructional details.

Having described my invention, what I claim as new, and desire to secure by Letters Patent of the United States, is—

1. In an electric spark-gap, having opposite

discharge-electrodes, heat-separating means consisting of a series of thin members of heat-conductive material extending laterally outward and located contiguous to the discharge-gap for diverting and separating from the electric current the heat effects and providing a cool discharge between said electrodes.

2. In an electric spark-gap, having opposite discharge-electrodes, heat-separating means located contiguous to the discharge-gap for diverting and separating from the electric current the heat effects and providing a cool discharge between said electrodes, said means comprising a series of separated conductor-plates in heat-conductive circuit therewith.

3. In an electric spark-gap, having opposite discharge-electrodes, heat-separating means located contiguous to the discharge-gap for diverting and separating from the electric current the heat effects and providing a cool discharge between said electrodes, said means comprising separated parallel plates mounted rigidly in conductive contact with the apparatus.

4. An electric spark-gap, having heat-separators in the form of thin conductor-plates mounted rigidly thereon.

5. An electric spark-gap, comprising opposite electrodes having a series of thin conductor-plates held rigidly adjacent but out of contact with each other, and extending outwardly from the electrodes.

6. In an electric spark-gap, an electrode having a rigid carrier provided with yielding holding means, and a discharge-bar removably held thereby, said holding means springing firmly in circuit-closing contact flat against the sides of said bar for giving a large conducting area for transmission of current.

7. In an electric spark-gap, an electrode having a rigid carrier provided with yielding holding means, and a discharge-bar removably held thereby, said bar having its forward sides converging to form a discharge edge, and said holding means conforming in shape thereto.

8. An electric spark-gap, having adjustable electrodes provided with two opposite equidistant, continuous discharge edges extending parallel to each other longitudinally across the apparatus.

9. An electric spark-gap, having electrodes provided with discharge edges extending lengthwise, parallel to each other, one of said electrodes being slidingly mounted in a support at a plurality of points, and means for adjusting said electrode toward and from the other electrode.

10. An electric spark-gap, comprising opposite electrodes of conductive material, said material being disposed in mass adjacent the discharge-gap and having the conductive material at the rear thereof distributed in thin radially-extending plates, the whole electrode being secured rigidly together for giving intimate conductive contact to all parts thereof.

11. In an electric spark-gap, comprising opposite electrodes, a percussion-plate secured in close relation to one of said electrodes and slightly back from the point thereof.

12. In an electric spark-gap, an electrode having a metal percussion-plate, secured slightly back from the discharge-point thereof and extending laterally therefrom for producing an even, uniform discharge of an alternating current.

13. An electric spark-gap, having a percussion-plate mounted on opposite sides of its discharge-point slightly back from the point thereof, and extending transversely to the direction of discharge.

14. An electric spark-gap, having an electrode provided with a conductor-plate mounted in contact therewith, slightly back from the point of discharge for preventing improper action in discharging an alternating current.

15. An electric spark-gap, comprising opposite electrodes, having discharge edges extending lengthwise, parallel to each other, and a percussion-plate mounted transversely to the air-gap between said electrodes and adjacent thereto, as and for the purpose set forth.

16. An electric spark-gap, comprising opposite electrodes having discharge edges extending lengthwise, parallel to each other, and opposite percussion-plates, mounted transversely to the air-gap between said electrodes and adjacent thereto, said percussion-plates restricting the active area of the electrode to the edges thereof.

17. An electric spark-gap, having an electrode provided with a central discharge-point of small area and adjacent receptive portions of large area, of conductive material extending in planes approximately at right angles to the direction of discharge.

18. An electric spark-gap, having a gap formed by laterally-extended discharge parts, and a percussion-plate coextensive with said gap.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

THOMAS B. KINRAIDE.

Witnesses:
GEO. H. MAXWELL,
R. S. FORD.

No. 884,499. PATENTED APR. 14, 1908.

T. B. KINRAIDE.

ELECTRIC SPARK GAP FOR INTERRUPTERS.

APPLICATION FILED APR. 24, 1906.

Fig. 1.

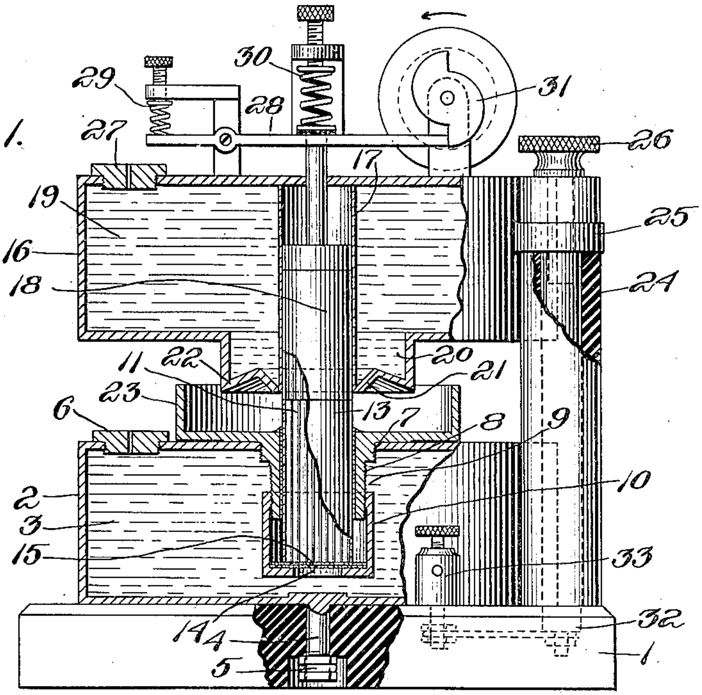


Fig. 3.

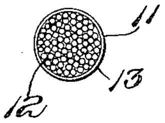
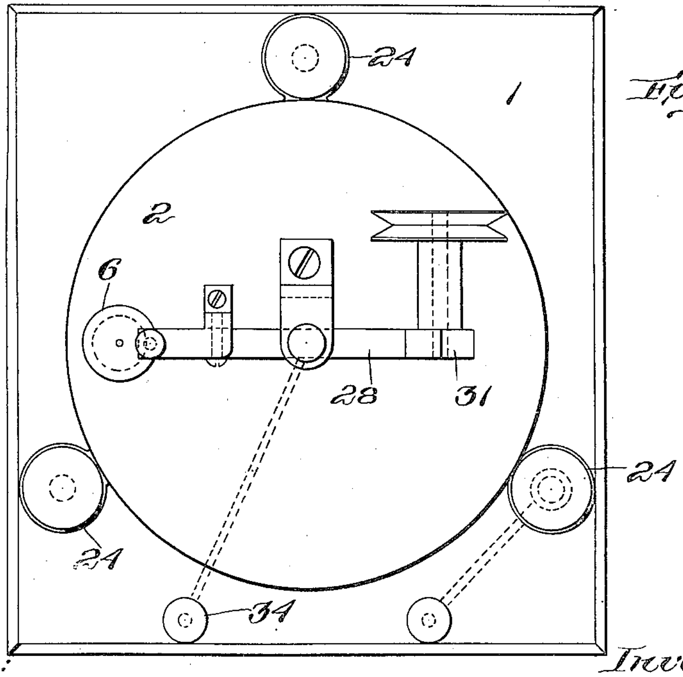


Fig. 2.



Witnesses:

Wm. J. Pike

M. J. Spalding

Inventor:

Thomas B. Kinraide,

by Geo. H. Maxwell,
Attorney.

UNITED STATES PATENT OFFICE.

THOMAS B. KINRAIDE, OF JAMAICA PLAIN, MASSACHUSETTS.

ELECTRIC SPARK-GAP FOR INTERRUPTERS.

No. 884,499. Specification of Letters Patent. Patented April 14, 1908.

Application filed April 24, 1906. Serial No. 313,452.

To all whom it may concern:

Be it known that I, Thomas B. Kinraide, a citizen of the United States, residing at Jamaica Plain, in the county of Suffolk and State of Massachusetts, have invented an Improvement in Electric Spark-Gaps for Interrupters, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

My invention relates to that class of spark gaps or interrupters especially adapted to convey heavy low voltage currents of high frequency such for example as developed by the coil shown in my Patent No. 615653. For instance, in my Patent No. 623318 I have provided opposite plates between whose plane surfaces the sparking takes place, and my present invention aims to maintain the electrodes cool and at the same time prevent permanent oxidizing of their discharge surfaces and thereby prolong their serviceableness indefinitely.

To the above end I have provided automatic means for blowing out the spark instantly, said means consisting of interposing automatically between the discharge surfaces an explosive gas or, in other words it consists in causing an explosion simultaneously with the discharge which effectually blows out the flame of the discharge. This explosion, in the preferred embodiment of my invention, is provided by causing a film of water to deposit on the discharge surface or between the two electrodes, said water preferably being maintained at the required point by capillary means. The presence of the water and especially the presence of adjacent bodies of water helps to maintain the electrodes cool and in proper operative condition.

Further details of my invention will be pointed out in the following description taken in connection with the accompanying drawings in which I have shown one embodiment of my invention.

In the drawing, Figure 1 represents in side elevation and vertical section, parts being broken away for clearness of illustration, one form of my invention adapted to operate as an interrupter or vibrator; Fig. 2 is a top plan view thereof. Fig. 3 is an end view of one of the electrodes.

On a suitable base 1 is a cooling box or tank 2 for holding water or other cooling medium 3, secured to said base by a stud 4 and nuts 5 and having a stopper 6 in its upper side for the admission of the water. In its upper side the cooling box 2 has a central threaded aperture 7 in which is removably mounted a tubular electrode holder 8 provided externally with fine threads 9 and engaged by an adjustable cap 10 for giving an extremely accurate and delicate adjustment to an electrode 11 supported thereby to slide in the holder 8.

The electrode 11 constitutes one of the important features of my invention and is preferably composed of a bunch of copper wires 12, packed tightly in a sheath or retaining envelop 13 and ground off flat at their opposite ends as clearly shown in Fig. 1. I have found that a bunch of copper wires thus bound together, will afford a permanent capillary means for maintaining the electrode constantly filled with enough water to provide the desired amount of moisture at the discharge end of the electrode ready at all times to volatilize and explode when the current passes, thereby blowing out the flame and washing away all oxidation and maintaining the ends of the sparking electrodes clean and in proper operative condition. The bunch of wires might be called a copper wire-wick, and it will be understood that the copper wires may be bound together in any wick-form, provided the desired capillary ducts or passages are provided through the wick or electrode of conductive material to permit the passage of the requisite amount of moisture for volatilizing at the discharge end. It is not necessary that wires as such should be used, as the holes or ducts may be secured in various other ways and in fact the porous condition may be provided in a large variety of ways. The essential feature as to this part of the invention, broadly considered, is to provide the electrode with means for permitting the water or moisture to enter an extremely limited and yet certain, continuous amount at the end of the electrode so as to be present at or between the meeting or discharge ends when the discharge takes place.

The electrode 11 is supported by the adjuster 10 which is provided with an opening or openings 14 for the free admission of water from the surrounding chamber and I prefer to interpose a damper in the form of one or more layers of blotting paper or similar substance 15 for filtering the water through to the end of the electrode for the purpose of limiting the capillary action of the latter and thereby further restricting the amount of water. By carefully regulating the amount of water admitted to the electrode, the products of combustion, *i. e.* the oxid, may be caused to blow out as dry dust or escape as thick paste or thin paste. This will be referred to again later.

Above the cooling box 2 I provide a similar box 16, provided with a vertical tubular center 17 in which is mounted an electrode 18 which may be similar in construction to the electrode 11. In order to carry the water or other cooling medium 19 as close to the sparking point as possible I provide a depression 20 in the box 16 having a central conical portion 21. Adjacent to this conical portion is a downwardly flaring shield 22 which co-operates with an upwardly extending shield or flange 23 in retaining the products of combustion while yet permitting a free circulation of air. The downwardly extending or overhanging part 22 operates to direct the ashes or products of combustion into the collecting basin formed by the cup-shaped top of the tubular portion 8. The upper portion of the apparatus is mounted on posts 24, the box 16 being provided with ears 25 for this purpose retained by thumb nuts 26. The box 16 has a stopper 27 the same as the stopper 6 of the lower box or cooler, and is provided in the apparatus of the drawings, with an operating device for causing rapid interruptions consisting of a striker 28, springs 29, 30 and cam 31 as shown and explained in my Patent No. 770431. It will be understood that the apparatus may be operated as a spark gap the same as in my Patent No. 623,318, above mentioned. The upper electrode connects by a rod 32 extending through one of the posts 24 with a binding post 33 and the other electrode connects by the stud 4 with a binding post 34.

One of the chief advantages of my invention is that it enables me to do away with the platinum points which have heretofore been necessary in high speed interrupters. By interposing the automatic blow out or deoxidizer, or moisture carrying electrode it becomes perfectly practicable to use copper electrodes, which has heretofore been impossible in this class of apparatus.

My invention enables the discharge to be steady and uniform without permitting imperative oxidizing of the electrodes and is especially adapted for currents of low voltage such as used with my flat coil (Patent No. 615653).

In use the cooling chambers are filled with water which maintains the electrodes cool, the body of water being large so as to keep up a more or less continuous circulation adjacent the discharge ends of the electrodes. At every discharge of current the water which has seeped through the damper 15 and traveled up the electrode 11 by capillary action, is volatilized and exploded, thereby driving off the products of combustion and maintaining the electrodes clean, so that although the latter are composed of copper or other inexpensive material of low refractory capacity, they maintain a high standard of efficiency. The admission of water is regulated so as to conform to the current used and for desired results, and the electrode is raised or lowered by correspondingly screwing up or down the cap 10.

The electrodes are inexpensive, readily put in place, and capable of long and continued use.

As already stated, I do not intend to limit myself to the precise details of construction herein shown, as a wide variety of embodiments is contemplated, within the spirit and scope of my invention.

Having described my invention, what I claim as new and desire to secure by Letters Patent is,

1. An apparatus of the kind described, comprising opposite discharge electrodes, and means for automatically providing a self-cleaning explosion between them at the moment of current discharge.

2. An apparatus of the kind described, comprising opposite discharge electrodes, and means for interposing a film of moisture between them at the moment of current discharge.

3. An apparatus of the kind described, comprising opposite discharge electrodes, and a supply of fluid adjacent one of said electrodes, said electrodes having capillary means for conveying said moisture to the discharge ends of the electrodes.

4. In an apparatus of the kind described, opposite discharge electrodes, and means for providing a film of moisture at their discharge area for keeping the electrodes clean.

5. In an apparatus of the kind described, an electrode having a multitude of capillary ducts closely arranged therethrough from end to end, said electrode consisting of a bundle of wires extending from one terminal of the electrode to the opposite terminal thereof, and means for binding said wires tightly together, the passages between said wires constituting said ducts.

6. In an apparatus of the kind described, an electrode having a multitude of capillary ducts closely arranged therethrough from end to end, said electrode consisting of a bundle of copper wires extending from one terminal of the electrode to the opposite terminal thereof, and means for binding said copper wires tightly together, the passages between said copper wires constituting said ducts.

7. In a high frequency discharge apparatus, opposite electrodes for discharging heavy

currents of low voltage, said electrodes being composed of conductive material of low refractory capacity, and provided with means operated by the current, for automatically cleaning all oxidation and products of combustion from their discharge ends at each discharge of current.

8. In an apparatus of the kind described, opposite water coolers, having central tubular holders, opposite electrodes adjustably mounted in said holders and projecting toward each other therefrom, at their discharge ends between said coolers, and means between said coolers for retaining the products of combustion which fall from between said electrodes.

9. In an apparatus of the kind described, opposite water coolers, having central tubular holders, opposite electrodes adjustably mounted in said holders and projecting toward each other therefrom, at their discharge ends between said coolers, and means between said coolers for retaining the products of combustion which fall from between said electrodes, said means consisting of a cup-shaped receptacle around one electrode and a projecting deflector about the other electrode.

10. In an apparatus of the kind described, a water cooler, a removable tubular holder therein, a cap adjustably secured to the inner end of said holder, said cap being perforated to admit water from the cooler, and a wick-like electrode mounted in said holder to engage said cap.

11. In an apparatus of the kind described, a water cooler, a removable tubular holder therein, a cap adjustably secured to the inner end of said holder, said cap being perforated to admit water from the cooler, a wick-like electrode mounted in said holder to engage said cap, and a moisture-limiting damper interposed between said electrode and the opening in said cap.

12. In an apparatus of the kind described, a water cooler, a removable tubular holder therein, a cap adjustably secured to the inner end of said holder, said cap being perforated to admit water from the cooler, and an electrode mounted in said holder, said holder having a cup-shaped outer end extending about the projecting end of said electrode.

13. A water cooler, having a depending central portion, a central tube extending up from said depending portion, and an electrode mounted in said central tube, said depending portion having a downwardly flaring deflector about said electrode for diverting the products of combustion.

In testimony whereof, I have signed my name to this specification, in the presence of two subscribing witnesses.

THOMAS B. KINRAIDE.

Witnesses:
Geo. H. Maxwell,
Wm. J. Pike.

No. 724,186. PATENTED MAR. 31, 1903.

H. JACKSON.

ELECTRICAL APPARATUS FOR THERAPEUTICAL WORK.

APPLICATION FILED JAN. 22, 1903.

NO MODEL.

Fig. 1.

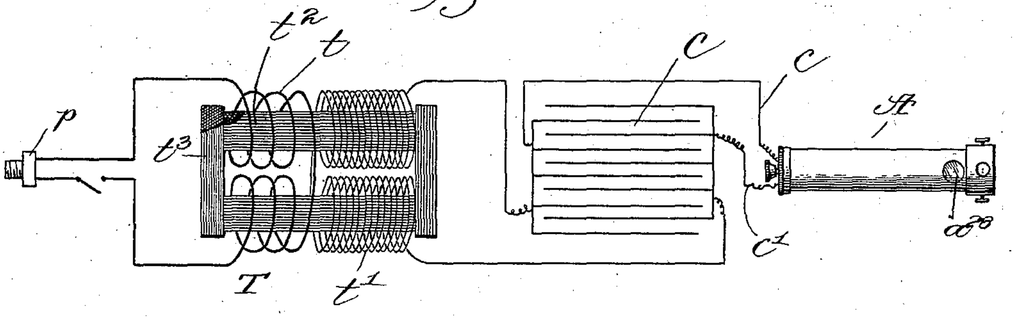


Fig. 2.

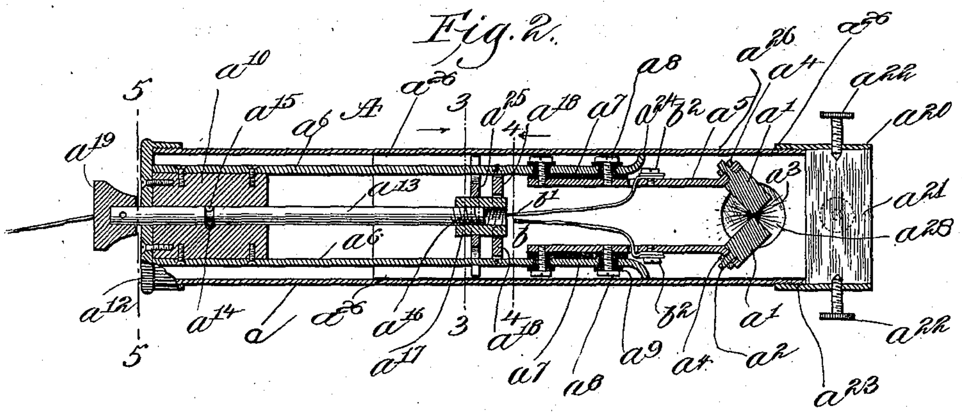


Fig. 3.

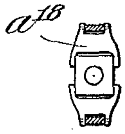


Fig. 4.

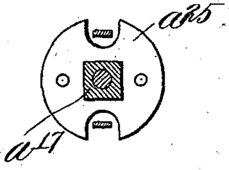
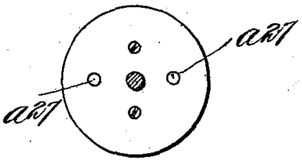


Fig. 5.



Witnesses.
W. C. Lunsford
Thomas J. Drummond

Inventor.
Howard Jackson,
by Crosby Gregory,
Att'ys.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

UNITED STATES PATENT OFFICE.

HOWARD JACKSON, OF NEWTON, MASSACHUSETTS.

ELECTRICAL APPARATUS FOR THERAPEUTICAL WORK.

SPECIFICATION forming part of Letters Patent No. 724,186, dated March 31, 1903.

Application filed January 22, 1903. Serial No. 140,161. (No model.)

To all whom it may concern:

Be it known that I, HOWARD JACKSON, a citizen of the United States, residing at Newton, county of Middlesex, and State of Massachusetts, have invented an Improvement in Electrical Apparatus for Therapeutical Work, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

My invention is an apparatus for producing ultraviolet rays for Finsen treatments, and by the latter term I intend to include the various forms of treatment suggested by medical men in the general line of Dr. Finsen's experiments, whereby various bacteriological growths are destroyed or their growth retarded by exposure to strong ultraviolet rays.

The object of my experiments and investigation has been to render this great discovery practically available to the medical profession generally by producing an apparatus capable of generating a superior light at minimum cost, thereby bringing the apparatus itself within the reach of all and making it possible to reduce the time required for successful treatment to such a short period as to adapt it to the frailest subject.

The constructional details and further advantages of my invention will be pointed out in the course of the following description, reference being had to the accompanying drawings, in which I have shown a preferred embodiment of my invention.

In the drawings, Figure 1 is a diagrammatic view of the apparatus complete. Fig. 2 is a central longitudinal section of the light-tube. Figs. 3 and 4 are cross-sectional views of the latter, taken, respectively, on lines 3 3 4 4, Fig. 2. Fig. 5 is an end view of said tube, taken on line 5, Fig. 2.

Referring more particularly to the light-producing tube A, which constitutes one of the important features of my invention, it will be seen that it comprises a tube a, which may be of any desired material suitable for the purpose and capable of withstanding the usage to which it is put, and mounted suitably in a tube are the electrodes and operating mechanism therefor.

The electrodes which I prefer to use are composed of iron, as indicated at a', said electrodes being short and provided at their supported ends with threaded studs a^2 and made square at their free ends a^3, being held in position by any suitable means, as by nuts a^4, which serve to clamp them against supports a^5, carried on an adjusting-frame, herein shown as consisting of opposite rods a^6, insulated from said supports at a^7 and connected thereto by screws a^8, mounted in insulating-bushings a^9. The frame a^6 has a block a^{10} at one end, preferably secured to a cap a^{12}, provided for closing the tube at one end, and in said block is mounted a rod a^{13} free to rotate, but held against longitudinal movement by a pin a^{14}, occupying a groove a^{15} in said rod. At its inner end the rod a^{13} is in threaded engagement at a^{16} with a nut a^{17}, connected by toggle-links a^{18} to the frame, so that upon rotating the rod a^{13} by its thumb-nut a^{19}, which projects through the cap a^{12}, the electrodes a' may be adjusted as required. Adjacent the end carrying the electrodes I provide a screen-holder a^{20}, adapted to receive a block of ice, rock-salt, or other suitable substance a^{21}, which may be held therein in any suitable way, as by means of set-screws a^{22}, and is removably mounted by threads or otherwise on the tube, as indicated at a^{23}. The frame a^6 preferably has its free end turned out, as indicated at a^{24}, to center the same and also preferably carries a spider or centering means a^{25} intermediate its length, and the tube a has an insulating-lining a^{26}, of asbestos or other material, adapted to withstand the heat and insulate the outside case or tube. Feed-wires b b' are secured at b^2 to the supports a^5 and pass out through the cap a^{12}, as indicated at a^{27}. Suitable sight-windows a^{28} are provided for watching the electrodes.

One main purpose of my invention is to obtain a light of maximum efficiency, whereby the time required for an exposure is reduced to a minimum, so as to avoid the necessity of a tedious and dangerous exposure or treatment.

I have found that by my apparatus the exposure can be reduced to an exceedingly-short period, five minutes being sufficient in some instances.

The iron electrodes are very rich in actinic rays, and by having their ends square I get an exceedingly sharp effect, and a further very important feature of my invention resides in providing, in connection with a condenser C, a step-up transformer T, which may receive its current from any usual alternating commercial circuit of one hundred to one hundred and ten volts, to which it may be connected by a usual electric-light plug p.

For general use the transformer may be wound with eight layers of three hundred and four turns of No. 16 magnet-wire for the coarse winding t and twenty layers of sixteen hundred turns of No. 24 wire for the fine winding t' on cores t^2, six by one and five-eighths inches, composed of fine iron wire connected at their ends by laminated iron yokes t^3 one and one-fourth by one and three-fourths by four and one-half inches, and as thus constructed the condenser of micanite sheets and tin-foil has a capacity of about one-fourth of a microfarad connected by heavy flexible conducting-wires c c' to the lamp A for carrying the rapidly-oscillating current.

This apparatus is not only relatively inexpensive, but can be used with any commercial alternating current, as stated. The apparatus is very readily portable and does not require a skilled operator, is rapid in its work—a treatment requiring only two to five minutes is capable of treating a large area satisfactorily—and is inexpensive to operate. It will run steadily without heating and does not require adjustment, except at long intervals, and the light is exceedingly rich in ultraviolet rays.

In the foregoing description I have stated the size and proportions which I have found the best for a convenient portable apparatus; but it will be understood that by increasing the condenser a larger arc may be produced, the transformer being modified within limits by using larger wire for carrying increased current; and it will be understood that I have set forth herein the said preferred proportions as an example to enable those skilled in the art to apprehend more clearly my invention.

For practical use it is necessary that the ultraviolet rays shall preponderate, and one object of my invention is to produce these rays in abundance without at the same time generating to an appreciable extent the other rays of the spectrum, or, in other words, I do not produce an intense light and then eliminate therefrom the superfluous and undesirable rays, (which is an expensive and cumbersome process;) but I have devised an apparatus which arrives at the desired result directly by producing the ultraviolet rays in great abundance by having a condenser operated by an alternating-current step-up transformer in time to deliver a high-tension high-frequency current directly to the arc-lamp. It is well known that a current of this character will produce an arc rich in ultraviolet rays. By my apparatus these rays are produced in an inexpensive, simple, and easily-operated mechanism capable of long continuous use.

I have aimed to produce an apparatus safely operable by a person not specially skilled and at a low cost, portable, and capable of operation with current commonly available.

My apparatus requires practically no attention, excepting turning the switch and occasionally adjusting the electrodes.

While I prefer to use iron electrodes, I do not wish to limit myself thereto, except where specified in the claims. These electrodes are mounted at an angle of about ninety degrees, as shown, and are held rigidly at one end, being capable of being turned to bring new portions of the sharp corners into action at the arc, these electrodes being inexpensive, long-lived, readily mounted, highly actinic, not liable to injury, interchangeable, and economical.

When it is desired to renew the screen a^{21}, the holder can be quickly removed from the tube and another put in place, or the screen material may be released by loosening the thumb-screws and a fresh supply substituted.

When it is desired to remove the electrodes or get at them, this may be done quickly simply by unscrewing the cap a^{12} and slipping the whole connected apparatus out of the tube.

Without undertaking to set forth all the modifications in form and arrangement of my apparatus and the various further advantages thereof, what I claim as new, and desire to secure by Letters Patent, is—

1. An apparatus of the kind described, comprising in series a source of alternating current, a step-up transformer and a condenser for producing a high-tension, high-frequency current, and an arc-lamp operated thereby for producing ultraviolet rays, substantially as described.

2. An apparatus of the kind described, comprising in series a source of alternating current, a step-up transformer and a condenser for producing a high-tension, high-frequency current, and an arc-lamp operated thereby for producing ultraviolet rays, said lamp being provided with iron electrodes, substantially as described.

3. An apparatus of the kind described, comprising in series a step-up transformer, a condenser, and an arc-lamp for producing ultraviolet rays, said lamp having square-ended iron electrodes arranged at an angle to each other for producing an arc between them, substantially as described.

4. In an apparatus of the kind described, a lamp comprising a case, a frame therein, electrode-supports carried thereby, and iron electrodes fixed rigidly on said supports, and means for adjusting said supports toward and from each other, substantially as described.

5. In an apparatus of the kind described, a lamp comprising a case, a frame therein, sup-

ports carried thereby, square-ended electrodes mounted in said supports, said electrodes being capable of being rotated in said supports, but immovable longitudinally therein, substantially as described.

6. In an apparatus of the kind described, a lamp, comprising a case, opposite electrodes, separate supports therefor, and means for adjusting said supports toward and from each other, comprising toggle-links and an operating member therefor connected with said links and extending outside of the case, substantially as described.

7. In an apparatus of the kind described, a lamp comprising a case, opposite electrodes, separate supports therefor, and means for adjusting said supports toward and from each other, comprising toggle-links, a nut connecting the same, and a threaded rod in engagement with said nut, said rod extending beyond the case, substantially as described.

8. In an apparatus of the kind described, a lamp comprising a case, opposite electrodes, separate supports therefor, and means for adjusting said supports toward and from each other, comprising a threaded rod for operating said links, said rod extending beyond the case, substantially as described.

9. In an apparatus of the kind described, a lamp comprising a case, a removable cap therefor, a frame rigidly connected to said cap, supports carried by said frame, electrodes mounted on said supports, whereby the frame and all parts connected therewith can be bodily removed with said cap, substantially as described.

10. In an apparatus of the kind described, a lamp, comprising a case having at one end a cap and at the other end a removable screen-holder provided with means for detachably holding a screen of ice, a frame, supports and electrodes, all carried by said cap, and means for maintaining the same out of contact with the case, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

HOWARD JACKSON.

Witnesses:
GEO. H. MAXWELL,
WILHELMINA C. HEUSER.

No. 676,583. Patented June 18, 1901.

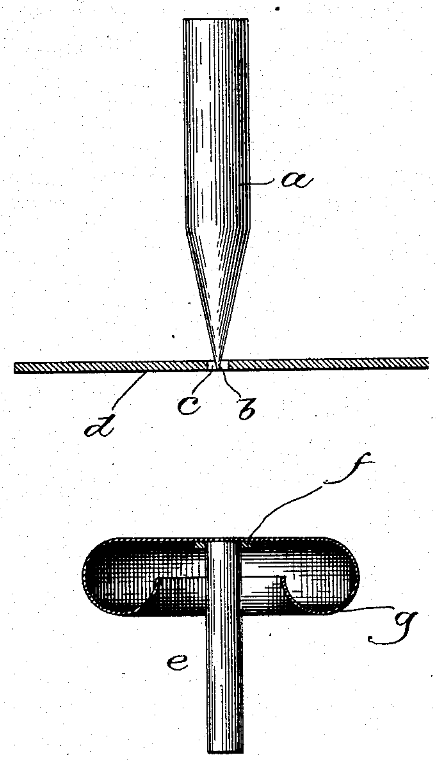
T. B. KINRAIDE.

ELECTRICAL APPARATUS.

(Application filed Aug. 13, 1900.)

(No Model.) 2 Sheets—Sheet 1.

Fig. 1



Witnesses.
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Adolf C. Kaiser.

Inventor.
Thomas B. Kinraide,
by Crosby & Gregory
Att'ys.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 676,583. **Patented June 18, 1901.**

T. B. KINRAIDE.

ELECTRICAL APPARATUS.

(Application filed Aug. 13, 1900.)

(No Model.) 2 Sheets—Sheet 2.

Fig. 2.

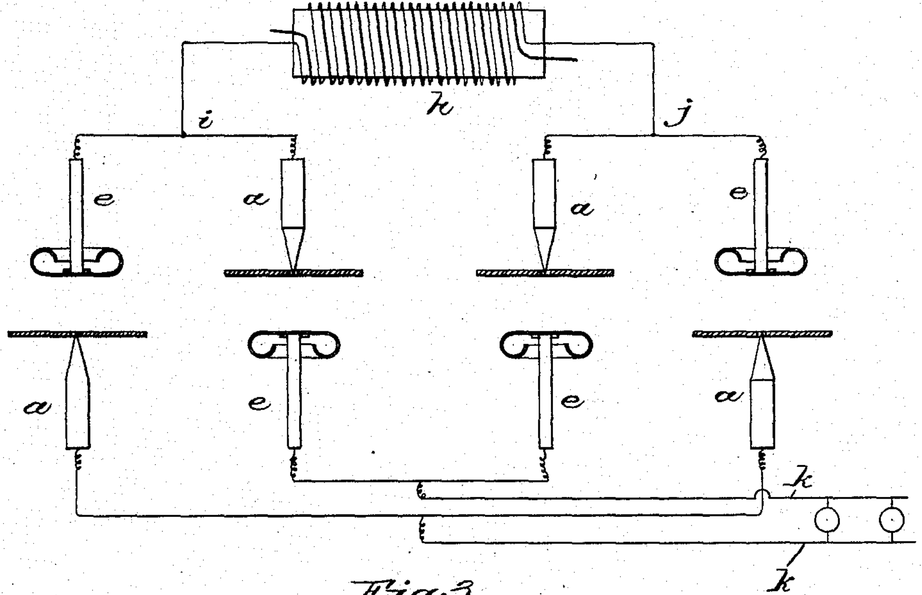
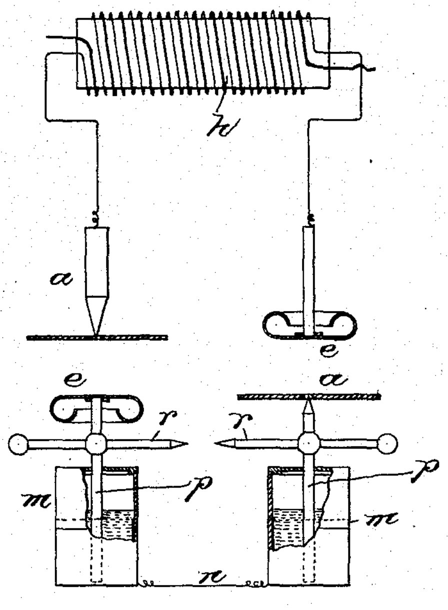


Fig. 3.



Witnesses.
Thomas J. Drummond
Adolf C. Karsen.

Inventor.
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By Crosby Gregory
Att'ys.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

UNITED STATES PATENT OFFICE.

THOMAS B. KINRAIDE, OF BOSTON, MASSACHUSETTS.

ELECTRICAL APPARATUS.

SPECIFICATION forming part of Letters Patent No. 676,583, dated June 18, 1901.

Application filed August 13, 1900. Serial No. 26,709. (No model.)

To all whom it may concern:

Be it known that I, THOMAS BURTON KINRAIDE, a citizen of the United States, and a resident of Boston, county of Suffolk, and State of Massachusetts, have invented an Improvement in Electrical Apparatus, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

My present invention is of wide application to various kinds of electrical apparatus and embodies certain important discoveries which I have made whereby I am enabled to positively maintain an electrical discharge in one direction only and under proper conditions to maintain said discharge continuously, producing, for instance, without the intervention of a commutator a continuous current directly from an alternating or intermittent current. Without necessarily stating that such is the fact, it may be supposed that there is simply electrical energy and that the presence of said energy is what we call a "positive" condition, and the absence of said energy is what we call a "negative" condition, and this, taken with my discovery that electric energy in its positive condition discharges reluctantly from a plane (without edges or angular or pointed surfaces) and discharges with perfect freedom from a point, enables me to control the direction of discharge of the current, and hence the accumulation of potential. The requisite conditions are provided by means of what I term an "extensionless point," which provides, as nearly as it can be done mechanically, the ideal discharge-electrode or positive condition for the outward flow of the electrical energy, and by means of what I term a "limitless plane," which provides in the same manner the receptive electrode or negative condition, in which there may be said to be an absence of energy (or a lower potential than that of the point from which the discharge comes) corresponding to a vacuous condition or absence of electrical pressure. By this means the electrical energy tends to discharge continuously in one direction only—viz., from the extensionless point to the limitless plane.

In the drawings, in which I have illustrated, largely diagrammatically, one form of my invention, Figure 1 represents, partly diagrammatically and largely in vertical cross-section, two electrodes arranged to provide the conditions above explained. Fig. 2 illustrates the application thereof for transforming an intermittent current into a constant current. Fig. 3 illustrates the application of my invention to Leyden jars for converting an intermittent discharge into a continuous discharge.

The general structural features of my invention may be very briefly stated.

Referring to Fig. 1, it will be seen that the electrode *a* is pointed or pencil-shaped and that the extreme discharge-point *b* is in or projected slightly through a small aperture *c* in a rubber or other flat disk *d*, which extends at right angles thereto, the purpose of this disk being to cut off the attracting area which would otherwise be present in the converging walls or surfaces of the electrode *a*. By this means I provide an "extensionless point," speaking electrically. By this term I mean a point in which the attractive area of the electrode relatively to the opposite electrode is limited to the point itself, or, in other words, in which the rubber disk *d* shields all the surface of the rod or electrode behind the very point thereof. The rubber disk constitutes means for cutting off the receptive area about the discharge-point. Opposite the electrode point *b* is the receptive electrode *e*, which maintains a negative condition relatively to the electrode *a* and which I have termed the "limitless plane," speaking again electrically, this electrode having a large receptive area and being provided with means for preventing the tendency to discharge, said means residing in presenting a receptive surface or plane without angles or points, and this plane is secured by providing a flat surface *f* of considerable relative extent and curving its edges back and inwardly, as indicated at *g*, whereby, viewed electrically, the surface is limitless, inasmuch as it has no termination within the influence of the discharge-point *b*.

In operation, the positive energy discharges invariably from the point *b* to the plane *f*, and there is no discharge from the latter back to the point, one reason therefor being that the attraction of the limitless plane is compelling, there being practically no attraction in the opposite direction due to the shielded point.

Applying the invention to practical uses, it will be seen that its field is important and large.

In Fig. 2 I have indicated a typical source of intermittent or alternating energy in the form of an induction-coil *h*, (operated by an alternating current,) whose terminals *i j* are provided with electrodes *a e* of the kind already described, and opposite these electrodes, which are arranged in pairs, are complementary electrodes *e a*, connected to a working circuit *k*, which it is desired shall have a continuous current.

Remembering that, as already explained, the extensionless-point and limitless-plane electrodes compel the discharge to take place in one direction, it will be seen that the intermittent or alternating discharge from the coil *h* is automatically transferred into a continuous current by the lower sets of electrodes as arranged in Fig. 2.

Again referring for further illustration to Fig. 3, it will be seen that I have arranged two Leyden jars *m*, having their outer coatings electrically connected by a wire *n* and their inner coatings connected by posts *p*, in which are mounted usual discharge-rods *r*, said posts, however, being provided on their upper extremities with the electrodes *a e*, opposite electrodes *e a* at the terminals of a coil *h*, (operated by an interrupted current.) By this means it is possible to maintain constant discharge at an approximately fixed potential similar to the discharge from a static machine, as the intermittent discharge from the induction-coil, which is the source of supply for the Leyden jars, is enabled to keep the Leyden jars at a practically saturated point, so that the latter can maintain a constant discharge between their rods *r*. This application of my invention is of great practical importance for the electrical spinning of fine fibers, such as silk, the rapid evaporation of liquids, and the accomplishment of effects that can be produced by the continuous running of a static machine. The static machine necessarily leaks, is not subject to control, and is of necessity uncertain, whereas by my invention all these objections are removed and the static discharge is rendered continuous and uniform.

My invention is what might be called an "electrical check-valve," as it permits the unlimited discharge of the current in one direction, but checks it from discharging in the opposite direction.

In measuring the effectiveness of my invention I have found that upon arranging the source of supply in such a manner that a positive discharge could be compelled to pass from the electrode *e* to the electrode *b* the electrodes could only be one-quarter the distance apart that they could be when the current was passing in the opposite direction, and even then the current had to be forced or compelled to discharge, because, if possible, it would seek some other outlet in preference to the one desired for the sake of experiment.

It will be understood that the practical embodiment of my invention may be varied within a wide range of equivalent embodiments, and accordingly I do not limit myself otherwise than as is hereinafter expressed in the claims, nor do I limit myself in respect to the applications of my invention, as, for instance, it is useful as a spark-gap capable of definite control; also, for a lightning-arrester and a multitude of other uses.

Having described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. The herein-described means for producing a continuous or unidirectional discharge, consisting of electrodes one of which has a discharge-point and is provided with means for cutting off the receptive area about said point, and another of which has a large receptive area provided with means for preventing the tendency to discharge, as set forth.

2. An electrode terminating in a comparatively fine point, and a flat shield extending approximately at right angles to said electrode and having a small aperture in which said point is located.

3. An electrode terminating in a plane, conducting-surface, having its edges curved or rolled rearwardly and inwardly.

4. In an electrical apparatus, a source of intermittent electrical energy having at its opposite terminals electrodes one of which has a discharge-point provided with means for cutting off the receptive area about said discharge-point and the other of which has a large receptive area provided with means for preventing the tendency to discharge, said means residing in presenting a receptive surface without angles or points, and other electrodes coöperating with said terminal electrodes, there being a discharge-point electrode arranged to coöperate with a receptive-area electrode and vice versa.

5. In an electrical apparatus, a source of intermittent electrical energy of high potential, means for compelling a unidirectional discharge from one end thereof, means opposite said end for receiving said discharge, said means being incapable, under ordinary conditions, of transmitting a back discharge, and means coöperating therewith for storing and maintaining said charge at an approximately fixed potential and maintaining a constant discharge therefrom.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

THOMAS B. KINRAIDE.

Witnesses:
GEO. H. MAXWELL,
JOHN C. EDWARDS.

No. 619,760. **Patented Feb. 21, 1899.**

T. B. KINRAIDE.

ELECTRICAL APPARATUS.

(Application filed May 5, 1898.)

(No Model.) 2 Sheets—Sheet 1.

Fig. 1

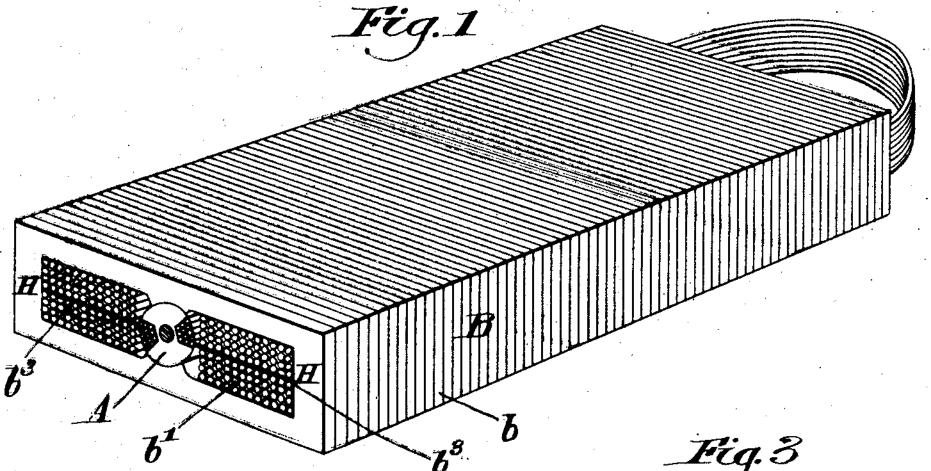


Fig. 2.

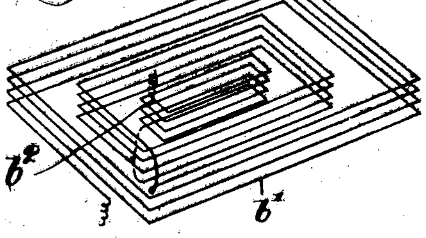


Fig. 3

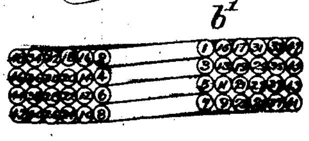


Fig. 4.

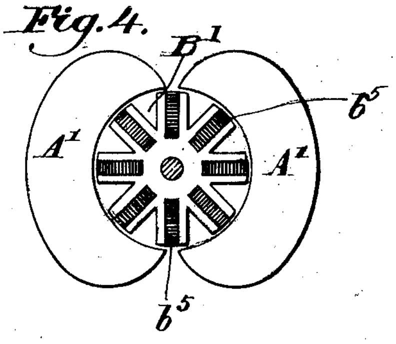
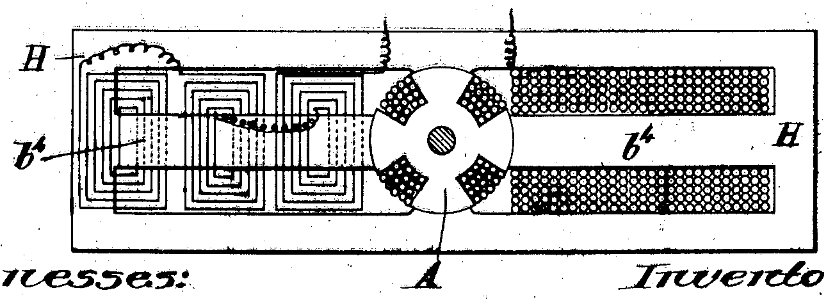


Fig. 5.



Witnesses:

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Fred S. Greenleaf

Inventor:

Thomas B. Kinraide

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attys.

No. 619,760. Patented Feb. 21, 1899.

T. B. KINRAIDE.

ELECTRICAL APPARATUS.

(Application filed May 5, 1898.)

(No Model.) 2 Sheets—Sheet 2.

Fig. 6.

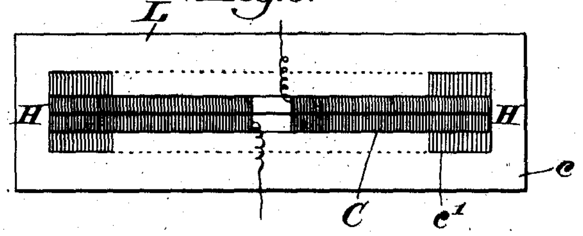


Fig. 7

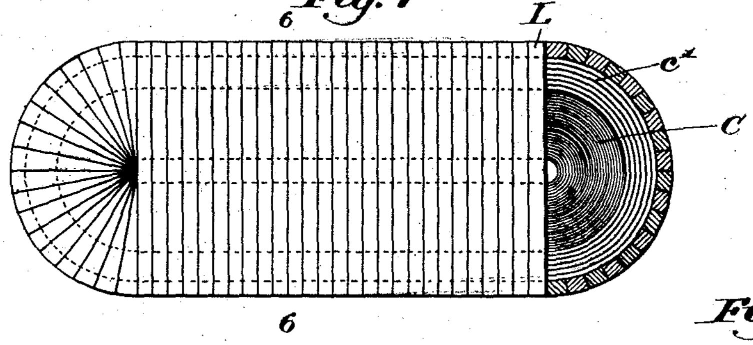


Fig. 9

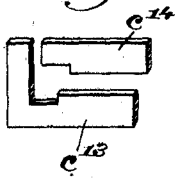


Fig. 8

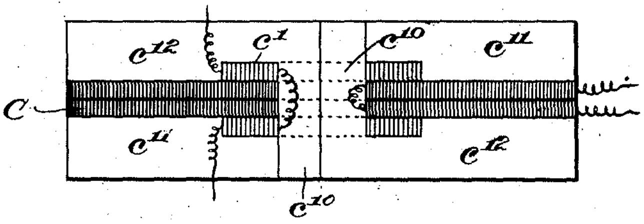


Fig. 10.

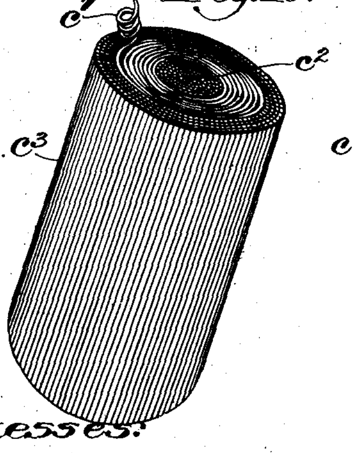
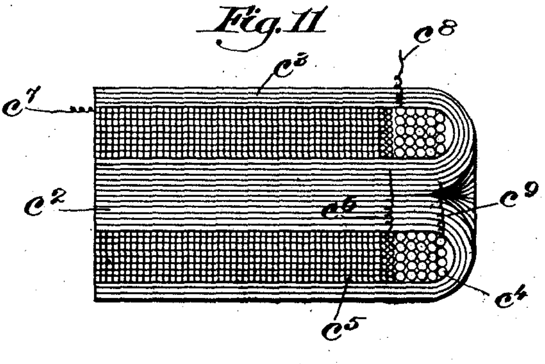


Fig. 11



Witnesses:

A. C. Harwood

Fred S. Greenleaf

Inventor:

Thomas B. Kinraide

by Crosby & Gregory

attys.

UNITED STATES PATENT OFFICE.

THOMAS B. KINRAIDE, OF BOSTON, MASSACHUSETTS.

ELECTRICAL APPARATUS.

SPECIFICATION forming part of Letters Patent No. 619,760, dated February 21, 1899.

Application filed May 5, 1898. Serial No. 679,800. (No model.)

To all whom it may concern:

Be it known that I, THOMAS B. KINRAIDE, of Boston, county of Suffolk, State of Massachusetts, have invented an Improvement in Dynamos, &c., of which the following description, in connection with the accompanying drawings, is a specification, like letters and figures on the drawings representing like parts.

My invention aims to accomplish an increased efficiency in electrical apparatus by means of a new winding thereof, which I have discovered to be the only proper winding for taking advantage of the natural impedance and inductance, so as to give a proper rise of potential in the direction desired only.

I have illustrated my invention in several different forms of apparatus in order that it might be fully apprehended, and the details of these devices will be more fully understood from the following description, reference being had to the accompanying drawings, and the invention will be more particularly defined in the appended claims.

In the drawings, Figure 1 is a perspective view, partly diagrammatic, illustrating one manner of constructing a dynamo to embody the principles of my invention. Figs. 2 and 3 are diagrammatic figures illustrating the manner of winding. Fig. 4 is a vertical section showing the principles of my invention applied to a different form of dynamo. Fig. 5 is a central transverse section of another form of dynamo, the right hand thereof showing the windings in section and the left hand thereof illustrating, diagrammatically, the manner of winding. Fig. 6 is a vertical transverse section taken on the line 6 6, Fig. 7, showing my invention applied to a transformer. Fig. 7 is a top plan view, partly in section, of said transformer. Fig. 8 is a central vertical sectional view of another form of transformer. Fig. 9 illustrates in perspective the plates constituting the magnetic field of the latter transformer. Figs. 10 and 11 show, respectively, in perspective and central longitudinal section a modified form of transformer.

Referring to Fig. 1, it will be seen that I have provided a rotating field A and a stationary armature B, the latter being made up of laminated plates or stampings b and internal windings b'. If such a form of dynamo were to be built with usual windings, the wire would be wound around one or the other or all the iron walls constituting the shell or magnetic field of the armature B. Instead of this method of winding I inclose all the wires within the stampings and I wind the wire in a peculiar manner illustrated in Figs. 2 and 3, where it will be seen that beginning at the inner terminal b^2 the wire is carried in a winding parallel to the rotating field A in successive turns, as indicated by numbers in Fig. 3, so that the wire is built up in successive layers from the inside outward until half of the cavity (at one side the heavy line b^3, Fig. 1) within the stampings is entirely filled, and then the same method of winding is followed until the opposite half of the cavity is entirely filled, the outer layers of the two bodies of windings being joined in circuit, so that we have a U-shaped mass of windings with the opposite terminals thereof next to the rotating field A. This winding will be clearly understood by following the numbers in Fig. 3 and observing the graphic representation of said winding in Fig. 2, from which it appears that successive coils are made until opposite parallel layers are formed, (indicated, respectively, by the figures 1 3 5 7 and 2 4 6 8,) and then the same wire continues laying adjacent layers, (indicated, respectively, by the figures 9 11 13 15 on one side and 10 12 14 16 on the other side,) the same wire then being carried back in the next layer, as indicated on one side by 17 19 21 23 and on the other side by 18 20 22 24, and then the last peripheral coil made in the half of the cavity of the armature filled by the windings thus far described continues over to the other half of said cavity, being coiled in precisely the same manner as before, the turns, however, proceeding from the periphery inward in the reverse manner to that already explained. In other words, supposing the last peripheral turn on one side the line b^3 to be made by the wire 48, this wire is continued past the dividing-line b^3 to the side of the cavity, which we will suppose to be vacant, winding precisely as before the turns 48 47, 46 45, 44 43, 42 41, which form the outermost or peripheral layer adjacent the ends of the stampings b, the same wire being thence continued in its windings to form adjacent and within said outermost layer another layer, (represented by the figures on one side 40 38 36 34 and on the other side 39 37 35 33,) and so on, winding in successive layers the same wire until said wire ends up with the last coil 2 1 of the last or innermost layer lying in line with the first or starting layer with which the winding was begun at the opposite end of the wire, the first coil 1 2 being at one terminal of the entire winding and the last coil 2 1 being at the other terminal thereof. The result is that as the field A rotates, thereby disturbing the induced magnetic conditions of the magnetic body B, which for the time being has become an induced magnet, the magnetic lines of the body B, when released from their inducing source, follow the usual law of induced magnets, and fall away from the region of the field A toward H, causing usual fluctuations in the winding of the armature, and the lines of force in the magnetic field provided by the enveloping body or jacket B fall on the wires of the windings and outwardly toward the ends thereof at H, thereby creating the greatest impedance at the adjacent portion of the windings and removing from the inner portions of the windings the hindrance of the lines of magnetic force, so that the rise of potential of the entire winding is free to take place at the terminals of the windings adjacent the field A, and consequently a high-potential region is maintained immediately adjacent the rotating field, and a low-potential region in the winding is maintained at the remote portions of the winding adjacent the parts marked H in Fig. 1. In Fig. 5 I have shown the same principle of winding applied to an armature made up of different-shaped stampings, the stampings shown in Fig. 5 having a central core portion b^4, around which the wire is wound. The principle of winding, however, is the same as before explained—that is to say, the current has to pass from the low-potential or outer portion of the armature along the entire length of the whole winding before it can reach the high-potential or inner portion of the armature adjacent the rotating field. This is different from previous windings in that the old way of winding would be to start, for instance, at the same end as in my winding; but instead of winding the wire outward in layers transversely to the portion b^4, as indicated, the wire would be wound directly on the portion b^4 in a spiral form throughout the length of said portion b^4, and then back again to the start in a second layer, and so on back and forth in layers extending parallel to the length of the armature instead of extending transversely thereto, and the result would be that the current would simply have to pass throughout the length of wire of one layer in order to pass from the low-potential region to the high-potential region of the armature, and then the current in traveling farther along the winding would pass back again along the next layer, traveling from the high-potential region to the low-potential region, and so on back and forth, according to the number of layers, until finally it would reach the outgoing terminal. I repeat, therefore, that the distinction of my winding thereover is that all the current as it is generated by the falling of the magnetic lines of force from the field A toward the end H is drawn off without impedance from the end of the winding away from which the lines of force are falling, and this takes place throughout the successive turns of the winding until every turn thereof back to the very end H discharges freely all its current in the one direction, all discharge in an opposite direction being prevented by the impedance of the lines of magnetic force at and falling toward the high magnetic potential ends H. Accordingly an armature constructed as shown in Fig. 5 would present constant high potential adjacent the rotating field, and the potential would be raised under the most favorable conditions, inasmuch as the lines of force of the surrounding magnetic field would be continually falling across the turns of wire back so as continually to keep releasing one and the same end of the winding from their impeding influence, while continuing to choke the opposite ends thereof adjacent H.

In Fig. 4 I have indicated the field at A' and have provided a rotating armature B', made up of stampings in usual manner, the difference over a usual dynamo being, however, that I have wound the armature as already described, b^5 indicating a ribbon winding, which begins adjacent the core of the armature and winds in successive layers thence outwardly in a radial direction, so that, for the reason already explained, there is a constant region of high potential adjacent the periphery of the armature and the inner terminals at the core are low potential. This is not only of advantage in that it gets all the benefit of the cutting lines of force in the magnetic field in the most natural manner as they fall across the turns successively from the inner to the outer portions of the windings, but also it requires only one terminal to be provided for the high-potential-current delivery from the apparatus, thereby permitting the return-conductor of the circuit to be correspondingly light and inexpensive for the extremely low voltage duty required of it.

In Figs. 6 and 7 I have shown a secondary C, wound in the same manner already described in detail and as shown in Fig. 1, the iron field c being cut away at c' to receive a primary preferably wound also on the same principle as the secondary. This produces what may be termed "a magnetic oscillator," in which all the lines of force of the magnetic field (whether closed or open) are permitted on an interruption of the current in the primary to fall across the secondary, so as to cut all the turns thereof successively from the center toward H and progressively throughout the length of the wire. In a transformer wound in the old way the lines of force would cut successive turns, to be sure, but would not cut said turns progressively along the whole wire, inasmuch as the windings would be transverse to the direction that I employ. This will be more readily understood viewing Figs. 10 and 11, which show the magnetic field as made up of wires forming at the center a core c^2 and bent around the outside of the windings to form a jacket c^3. The old way of making a transformer in this form would have been to wind the primary along the core c^2 from one end to the other and then wind the secondary over the primary in successive layers parallel to the core back and forth. My winding, it will be seen, is entirely different from this, for I wind the primary c^4 at one end, as clearly indicated, and then wind the secondary c^5 in successive layers transversely to the core c^2 instead of parallel thereto, so that all the current passes out from the delivery or outgoing terminal c^7 without any impedance, because as the lines of force fall and cut the turns, beginning at c^7 and falling back toward the opposite terminal c^6, the wire is left free to discharge its current in one direction only, and this continues until all the wire is left free back to its terminal c^6. In Fig. 8 I have shown a form of transformer wound on the same plan, but having a central core c^{10} and opposite disk-like magnetic fields c^{11} c^{12}, connected therewith, the stampings in this case being made up of pieces c^{13} c^{14} (shown in detail in Fig. 9) and put together in an obvious manner.

Having described my invention, what I claim, and desire to secure by Letters Patent, is—

1. In an electrical apparatus, a body producing a magnetic field, a winding within the influence of said body, means to maintain high-potential and low-potential regions respectively in opposite parts of said magnetic field, and means to cause fluctuations of said field, said winding being wound to present conditions of electrical potential related inversely to the magnetic potential of the field, and having decreasing potential throughout its entire length from its high-potential region to its low-potential region, substantially as described.

2. In an electrical apparatus, an enveloping body providing a magnetic field for the apparatus, a winding arranged in and subject to the influence of said field, means to set up conditions of potential high and low relatively to each other in different regions of said field, and means to cause fluctuations of said field, said winding having its terminals adjacent the region from which the magnetic lines fall on a fluctuation of said field, said winding being similarly wound from its said terminals to its intermediate portion, the latter being adjacent the region toward which said magnetic lines fall, and being wound to present decreasing potential throughout its entire length from its said respective terminals to its said intermediate portion, substantially as described.

3. In an electrical apparatus, a body providing a magnetic field for the apparatus, a winding arranged in and subject to the influence of said field, means to set up conditions of potential high and low relatively to each other in different regions of said field, a primary winding restricted to the region of said field toward which the magnetic lines fall, said first-mentioned winding being wound in said field to present conditions of electrical potential related inversely to the magnetic potential of the field, said winding having decreasing potential throughout its entire length from its high-potential region to its low-potential region, substantially as described.

4. In an electrical apparatus, a magnetizable shell or jacket providing a magnetic field for the apparatus, a winding arranged in and subject to the influence of said field, means to set up conditions of potential high and low relatively to each other in different regions of said field, a primary winding restricted to the region of said field toward which the magnetic lines fall, said first-mentioned winding having its terminals adjacent the region away from which the magnetic lines fall, being similarly wound from its said terminals to its intermediate portion, the latter being adjacent said primary winding, and said first-mentioned winding being wound to have its potential decreasing throughout its entire length from its said respective terminals to its said intermediate portion, substantially as described.

5. In an electrical apparatus, a thin, flat secondary winding wound in two similar bodies side by side proceeding from the intermediate portion of the winding constituting the secondary and each of said bodies winding in successive layers or coils progressively shorter throughout its length from the periphery to the central portion thereof, and a primary winding restricted to the peripheral portion of said secondary, part thereof being on one side and part on the opposite side of said secondary, substantially as described.

6. In an electrical apparatus, a thin, flat secondary winding wound in two similar bodies side by side proceeding from the intermediate portion of the secondary and each winding in successive layers or coils progressively shorter throughout its length from the periphery to the central portion thereof, and a primary winding restricted to the peripheral portion of said secondary, part thereof being on one side and part on the opposite side of said secondary, and a magnetic jacket or body inclosing said windings, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

THOMAS B. KINRAIDE.

Witnesses:
GEO. H. MAXWELL,
JOHN C. EDWARDS.

No. 623,317. Patented Apr. 18, 1899.

T. B. KINRAIDE.

ELECTRICAL BREAK.

(Application filed Sept. 24, 1898.)

(No Model.)

Fig: 1.

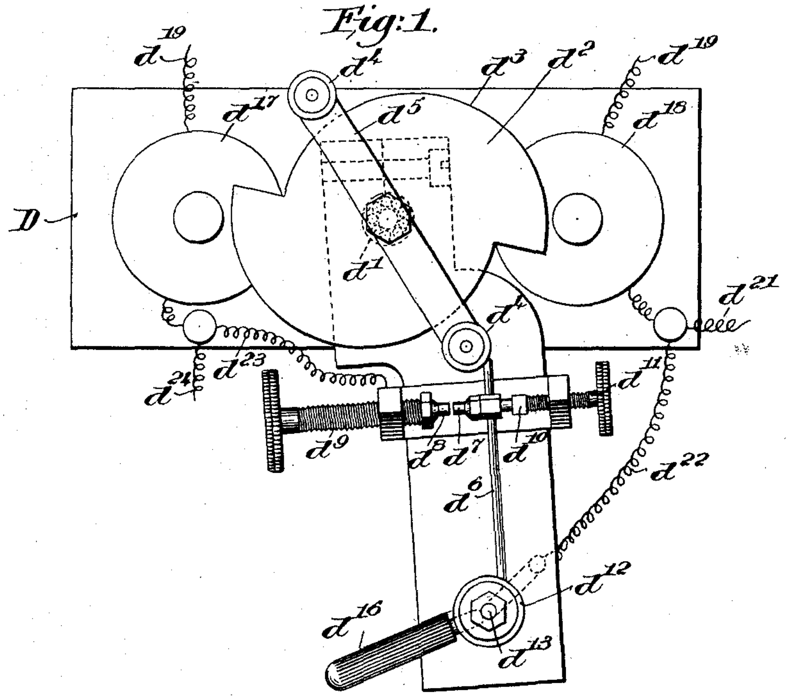
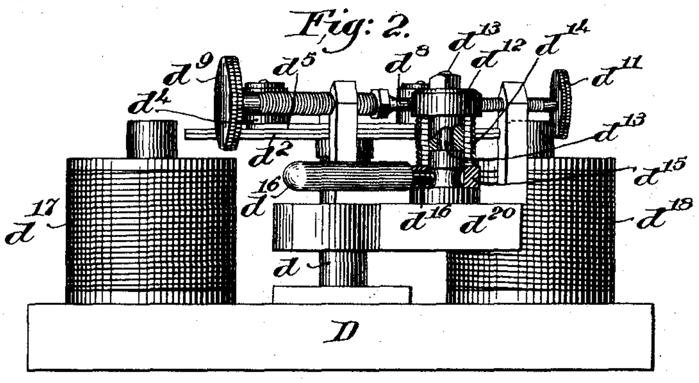


Fig: 2.



Witnesses,
Edward F. Allen.
Fred S. Greenleaf

Inventor,
Thomas B. Kinraide,
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THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

UNITED STATES PATENT OFFICE.

THOMAS B. KINRAIDE, OF BOSTON, MASSACHUSETTS.

ELECTRICAL BREAK.

SPECIFICATION forming part of Letters Patent No. 623,317, dated April 18, 1899.

Original application filed May 5, 1898, Serial No. 679,799. Divided and this application filed September 24, 1898. Serial No. 691,757. (No model.)

To all whom it may concern:

Be it known that I, THOMAS B. KINRAIDE, of Boston, county of Suffolk, State of Massachusetts, have invented an Improvement in Electric Breaks, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

My present application is a division of my application, Serial No. 679,799, filed May 5, 1898.

Electric breaks as heretofore provided have been subject to considerable sparking, which is not only destructive of the apparatus, but is very objectionable in its effects on the current and system being operated, this being especially true of rotary breaks which operate by means of a brush in frictional engagement with a rotating surface. Accordingly I have invented a break in which there is no chance for arcing, as there is no surface to arc over, and also a leading object of my break is to provide a means for making an exceedingly quick break with a relatively long period of closed circuit, my break rendering it possible to regulate the period of closed circuit accurately. Many considerable advantages resulting from this construction will occur to those skilled in the art.

The details of construction and principles of operation of my improved break will be more fully pointed out in the following description, reference being had to the accompanying drawings, in which I have illustrated a preferred embodiment of my invention, and the latter will be more particularly defined in the appended claims.

In the drawings, Figure 1 is a top plan view of one form of my break. Fig. 2 shows the same in elevation.

On a suitable base D, I journal, in a central post or bearing d, a spindle d' of an iron plate or armature d^2, having two or more regions of varying mass of magnetic material, herein shown in the form of eccentric edges d^3, as clearly shown in Fig. 1.

My object is to provide regions of increasing magnetic attraction to coöperate with one or more suitable electromagnets or solenoid devices so located as to successively attract these regions of varying mass of magnetic material for rotating the armature, as will now be explained.

Mounted on or otherwise connected to rotate with the armature d^2 are one or more small antifriction-rolls d^4, two being herein shown mounted at the opposite ends of a bar d^5, clamped adjustably on the plate d^2. These rolls or circuit-interrupters are preferably of indurated fiber.

Mounted to extend into the path of the rolls d^4 is an arm, (shown as a wire d^6,) carrying a hammer d^7 to contact with an anvil d^8 on a post d^9 and limited in its movement by a fiber stop d^{10} on the end of an adjusting-screw d^{11}. The wire d^6 is carried by a hub d^{12}, loose on a pin d^{13} and held under tension by a spring-coil d^{14}, Fig. 2, fastened at one end to said hub and at its other end to a nut d^{15}, carrying an adjusting or set screw d^{16}, so that by loosening the set-screw and swinging its handle one way or the other the resistance of the arm d^6 may be varied.

Preferably adjacent the periphery of the armature d^2 I place attracting means, herein shown in the form of solenoids or electromagnets d^{17} d^{18}, connected with the main or other source of current by wires d^{19}, which enter the solenoids at their inner terminals, so that as the magnets d^{17} d^{18} are energized they attract the armature or plate d^2, and by the increasing pull exerted thereon on account of the eccentric surfaces d^3 they cause the plate to rotate with a speed only checked by the striking of the interrupters d^4 against the end of the arm d^6, said rolls being placed relatively to the highest points of the surfaces d^3, so that they cut off the current just before said highest points get opposite the propelling-magnets, thereby permitting the momentum of the plate or armature d^2 to carry said highest points beyond the magnets sufficiently to prevent the latter exerting any retarding influence on the rotation of the break.

Preferably I mount the anvil and hammer on a swinging ledge or carrier d^{20}, journaled on the post d, so that I am enabled to regulate the speed of the break simply by swinging the carrier d^{20} one way or the other. The same effect may be obtained by shifting the roll or rolls d^4 on the plate d^2, provided they are carried, as preferred, on a bar d^5, so that they can be shifted. This adjustment cannot of course take place while the apparatus is in operation, and therefore for instantaneous regulation of the apparatus I provide the swinging carrier d^{20}.

A movement of the carrier from right to left causes the current to be broken before the armature has reached its point of greatest attraction, and as it is moved farther toward the left the pull on the armature exerted by the magnets is diminished more and more, and the speed of rotation of the armature is correspondingly reduced, thereby reducing the number of breaks and at the same time lengthening the time which the circuit being interrupted is closed.

I place the arm or wire d^6 slightly tangential to the armature, as will be seen viewing Fig. 1, in order that the rolls d^4 may strike the extreme end thereof with least friction, striking outward instead of square against the end. The arm d^6 is connected to the main or branch therefrom at d^{21} by means of any suitable conductor d^{22}, and the anvil d^8 has a connection d^{23} to the delivery end d^{24} of the circuit, as will readily be understood.

In operation the magnets being energized attract the eccentric surfaces or other varying masses of magnetic material, so as to cause the armature to rotate over to the left, Fig. 1, the circuit being completed at d^7 d^8 until the very moment when the interrupter d^4 strikes the free end of the arm d^6, whereupon the circuit is instantaneously broken, and as this time occurs slightly before the highest points or places of greatest attraction of the armature come opposite the solenoids the latter are rendered inactive merely during the moment when the momentum of the armature is carrying the latter by the solenoids, so as to bring the region of least magnetic mass again opposite the solenoids in position for the latter, upon becoming active by the making again of the circuit, to renew their pull upon the armature, and thereby continue its rapid revolution. This action is rapidly repeated at every make and break of the instrument.

I prefer to provide opposite solenoids in order to render the device perfectly balanced and smooth-running, although it will be understood that variations in this and in all other details of my invention may be made.

By the use of my invention the time-period of closed circuit may be made as considerable as desired. With any usual break this would be impossible, for the reason that in order to give an equivalent period of closed circuit the brush would of necessity remain upon the surface of the break so long as to heat frictionally the surfaces, so as to produce a constant arc, ultimately destroying the break as well as the efficiency of the circuit. In my break there is not only no chance for it to arc, as there is no surface for it to arc over, but the break itself is so exceedingly quick that there is not even a spark at the time of break, but there is merely occasionally a residual spark upon the closing of the break.

Having described my invention, what I claim, and desire to secure by Letters Patent, is—

1. An electric break comprising a rotating member, an electromagnet, a break device, and means driven by said rotating member for interrupting said break device, said rotating member presenting a surface of attraction to said magnet eccentric to the center of rotation of said member, substantially as described.

2. An electric break comprising a rotating member, an electromagnet, a break device, and means driven by said rotating member for interrupting said break device, said rotating member presenting a surface of attraction to said magnet eccentric to the center of rotation of said member, and means for varying the time of interruption of said break device relatively to the point of highest attraction of said eccentric surface, substantially as described.

3. An electric break comprising a rotating member, an electromagnet, a spring, a break device, means to vary the resistance of said break device, and means driven by said rotating member for interrupting said break device, said rotating member presenting a surface of attraction to said magnet eccentric to the center of rotation of said member, and means for varying the time of interruption of said break device relatively to the point of highest attraction of said eccentric surface, substantially as described.

4. An electric break comprising a rotating member having regions of varying mass of magnetic material producing regions of increasing magnetic attraction, an electromagnet adjacent said rotating member, a break device, and an interrupter driven by said rotating member for interrupting the break device, substantially as described.

5. An electric break comprising a rotating member having regions of varying mass of magnetic material producing regions of increasing magnetic attraction, an electromagnet adjacent said rotating member, a break device, and an interrupter carried by said rotating member for interrupting the break device, substantially as described.

6. An electric break comprising a rotating member having regions of varying mass of magnetic material producing regions of increasing magnetic attraction, an electromagnet adjacent said rotating member, a break device, and a pivoted roll carried by said rotating member for interrupting the break device, substantially as described.

7. An electric break comprising a rotating member having regions of increasing magnetic attraction, an electromagnet adjacent said rotating member, a break device, and a pivoted roll carried by said rotating member for interrupting the break device, and means

for adjusting said roll on said rotating member, substantially as described.

8. An electric break comprising a rotating member having regions of increasing magnetic attraction, an electromagnet adjacent said rotating member, a break device, and a bar fixed on said rotating member and provided with rolls pivoted thereon at its opposite ends in line with and to interrupt said break device, substantially as described.

9. An electric break comprising a rotating member having regions of increasing magnetic attraction, an electromagnet adjacent said rotating member, a break device, and an interrupter carried by said rotating member for interrupting the break device, said break device being mounted on a carrier movable concentrically to said rotating member, substantially as described.

10. An electric break comprising a rotating member having regions of increasing magnetic attraction, an electromagnet adjacent said rotating member, a break device, and a revolving interrupter driven by said rotating member, said break device including a yielding arm projecting obliquely into the path of said interrupter, substantially as described.

11. An electric break comprising an arm carrying a hammer, an anvil opposite said hammer, said arm being yieldingly supported and provided with means for regulating the tension or resistance thereof, an interrupter for engaging the free end of said arm, and automatic means operated by the current being broken for driving said interrupter, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

THOMAS B. KINRAIDE.

Witnesses:
GEO. H. MAXWELL,
ALEXANDER C. PROUDFIT.

No. 623,318. **Patented Apr. 18, 1899.**

T. B. KINRAIDE.

ELECTRICAL SPARK GAP.

(Application filed Sept. 24, 1898.)

(No Model.)

Fig: 1.

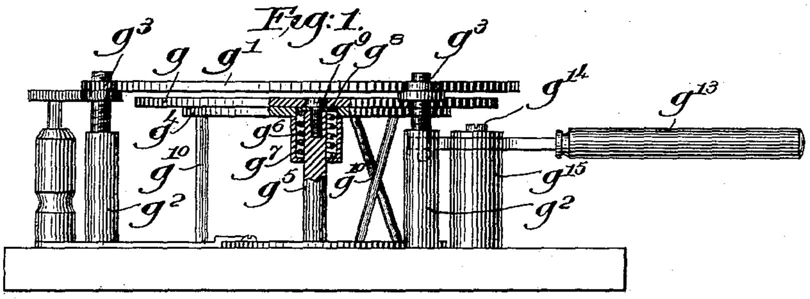


Fig: 3.

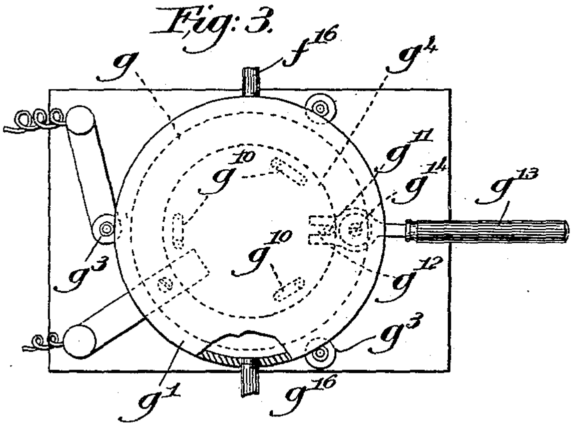
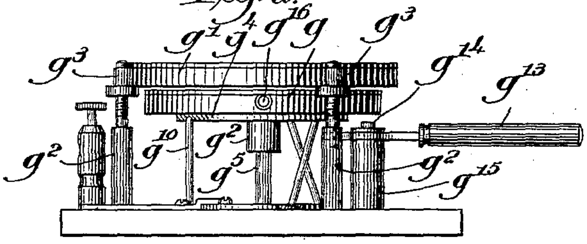


Fig: 2.



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THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

UNITED STATES PATENT OFFICE.

THOMAS B. KINRAIDE, OF BOSTON, MASSACHUSETTS.

ELECTRICAL SPARK-GAP.

SPECIFICATION forming part of Letters Patent No. 623,318, dated April 18, 1899.

Application filed September 24, 1898. Serial No. 691,758. (No model.)

To all whom it may concern:

Be it known that I, THOMAS B. KINRAIDE, of Boston, county of Suffolk, State of Massachusetts, have invented an Improvement in Electric Spark-Gaps, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

The more recent developments in electrical matters, and particularly in the line of experimental research in connection with static electricity, have developed conditions requiring the discharge of such enormous potentials and amperage as to render the apparatus heretofore provided for such purposes inefficient and largely useless, for the reason that these enormous discharges which the electrician frequently desires to experiment or deal with very quickly render inoperative or destroy such usual apparatus.

Accordingly it is the object of my present invention to provide a practically indestructible discharge apparatus to meet the more exacting requirements of the present day; and to that end I provide a spark-gap which is virtually self-recuperative and comprises opposite parallel discharge-surfaces of considerable area, which, besides their practically indestructible character, possess numerous very important advantages, all as will be more fully pointed out in the course of the following detailed description of the apparatus, reference being had to the accompanying drawings, illustrative of preferred embodiments thereof.

In the drawings, Figure 1 represents in side elevation a simple form of my improved spark-gap. Fig. 2 is a similar view showing a modification. Fig. 3 is a top plan view of the form of apparatus shown in Fig. 2.

While the spark-gap which constitutes my invention and which I will now describe is primarily intended for use in discharging condensers, as shown in my application, Serial No. 679,799, filed May 5, 1898, it will be understood that it is not limited thereto, but may be employed in various other relations.

I provide electrodes preferably in the form of opposite parallel disks g g', the air-gap between whose plane surfaces constitutes the spark-gap, the extended area of these electrodes preventing the tendency of the condenser, for example, to discharge until it has reached its maximum charge and also causing the discharge to be exceedingly sudden when it does take place and the disks not being liable to become unduly heated.

The spark-gap constitutes virtually a self-recuperative or indestructible condenser, as it were, the parallel and preferably plane metallic surfaces g g' being the discharge-surfaces, which discharge through or across the intervening air dielectric. The air-gap is broken through when the voltage has exerted a sufficient strain upon the air to rupture it. The larger the disks are the greater condenser capacity will they have, and hence the farther apart they will spark.

At each discharge of the condenser a small portion of the plates g g' is oxidized, the successive discharges producing very thin oxidation here and there until the entire surfaces of the two disks are completely oxidized. Suitable means is provided for accurately adjusting these plates relatively to each other and regulating their distance apart, or, in other words, for controlling the resistance of the intervening gaseous dielectric, and, referring to the drawings, where I have shown a preferred means for accomplishing my object, it will be seen that I provide a plurality of posts g^2, threaded at their upper ends and carrying shouldered nuts g^3, on the shoulders of which is placed the top disk g'. The opposite plate g rests on a support or table g^4 and is mounted loosely on a post g^5, being normally held downwardly by a spring g^6, contained in a hanger or housing g^7, depending from the table g^4, said spring bearing at one end against the flanged lower end of the hanger g^7 and at its other end bearing against a washer g^8, retained by a screw g^9, whose head enters a hole or recess in the plate g for centering the latter.

The plate g is provided on its under side with a plurality of recesses or sockets, herein shown as three in number, which receive props or struts g^{10}, projecting upwardly from the base of the instrument. These props g^{10} are of precisely equal length, so that they support the plate g in absolute parallelism to its opposite plate g'. The support g^4 has depending from its lower side a stud g^{11}, which is engaged by the bifurcated end g^{12} of a lever g^{13}, pivoted at g^{14} to a post g^{15} on the base.

By this provision the most delicate adjustment is possible simply by swinging the lever g^{13} one way or the other, so as to incline the struts g^{10} more or less, and thereby increase or decrease the distance between the plates g g', the nuts g^{3} being depended upon for the coarser adjustments of the plates.

In Figs. 2 and 3 I have shown the plates g g' as hollow and provided with water-circulation pipes g^{16} in order that they may be absolutely prevented from all heating under extraordinary conditions. Under usual conditions, however, this provision is entirely unnecessary, it being sufficient simply to provide the plates, as shown in Fig. 1.

When the adjacent surfaces of the plates have become entirely oxidized, the plates may be turned over and their opposite sides used, and when both sides have become oxidized they may be readily removed and scoured off without destroying any of their adjustments.

My apparatus makes possible the sudden discharge of a condenser after the latter has reached a certain predetermined point, and said discharge is of great volume or large amperage and of a very sudden and abrupt nature, as the current will not break across the spark-gap until it cannot help doing so, and when it does do so the discharge takes place with a minimum heating effect, not interfering with the efficiency, with very rapid and with very short and sharp oscillations incapable of being obtained between a ball or point discharge gap.

The adjustment of the plates relatively to each other regulates the amperage-discharge of the instrument being discharged.

Having described my invention, what I claim, and desire to secure by Letters Patent, is—

1. A spark-gap of the kind described for use in a condenser-circuit, said spark-gap presenting opposite parallel discharge-surfaces of relatively large areas and means for regulating the discharge distance between said parallel surfaces, whereby a condenser charge may be automatically governed, substantially as described.

2. The herein-described spark-gap comprising opposite electrodes presenting parallel discharge-surfaces, one of said electrodes being supported on three or more struts of equal length, and means for rotating said strut-supported electrode about its center, whereby its adjustment may be varied to and from the opposite electrode, substantially as described.

3. A spark-gap, comprising two permanent large superficial areas parallel to each other, constituting opposite discharge-surfaces, and an interposed gaseous dielectric, said discharge-surfaces having condenser capacity for breaking down the intervening dielectric, and the latter automatically restoring or renewing itself, substantially as described.

4. A spark-gap comprising opposite hollow plates or disks having parallel discharge-surfaces, means for regulating the discharge distance between said surfaces, and circulation-pipes entering the same, whereby a circulation of water may be maintained for keeping the plates or disks cool, substantially as described.

5. A spark-gap comprising three or more posts, shoulders adjustable thereon, a plate or disk supported on said shoulders, a second plate below the same, a support therefor, three or more upright struts loosely engaging said support, and means to rotate said support about its center, whereby said struts are simultaneously and similarly moved for varying the distance apart of said plates, substantially as described.

6. A spark-gap comprising a central post, a plurality of supporting-posts, two plates, one carried by said supporting-posts and the other adjacent said central post, three or more similar struts supporting said lower plate, a spring maintaining said struts in proper supporting relation, and means to rotate the lower plate on said central post, substantially as described.

7. A spark-gap comprising a plurality of supporting-posts, two plates, the lower plate being pivotally mounted, three or more similar struts supporting said lower plate, and the upper plate being supported by said supporting-posts, a lever pivotally mounted adjacent said lower plate and loosely connected therewith at its inner end for rotating said plate and tipping said struts, substantially as described.

8. A spark-gap comprising a central post, a plurality of supporting-posts, two plates, the lower plate being pivotally mounted concentrically to said central post, a hanger depending adjacent said post, a spring between said post and hanger and engaging the hanger at its lower end and held by the post at its upper end, three or more similar struts supporting said lower plate, and the upper plate being supported by said supporting-posts, a lever pivotally mounted adjacent said lower plate and loosely connected therewith at its inner end for rotating said plate and tipping said struts, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

THOMAS B. KINRAIDE.

Witnesses:

GEO. H. MAXWELL,
ALEXANDER C. PROUDFIT.

No. 689,199. **Patented Dec. 17, 1901.**

T. B. KINRAIDE.

ELECTRODE.

(Application filed May 2, 1901.)

(No Model.)

Fig. 1.

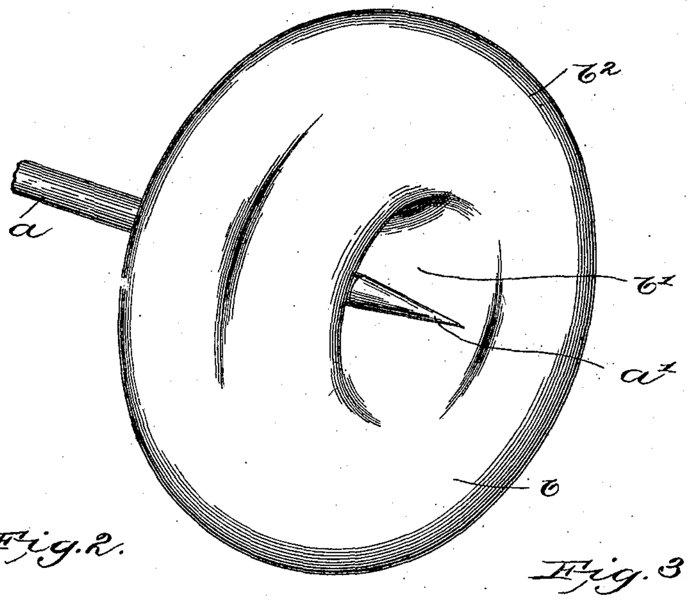


Fig. 2.

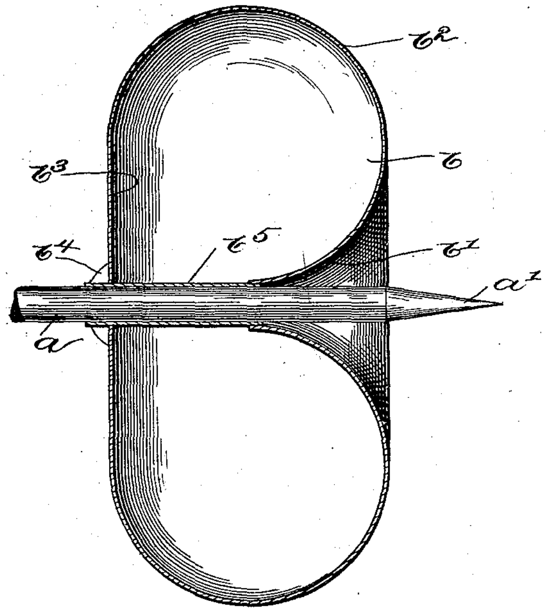
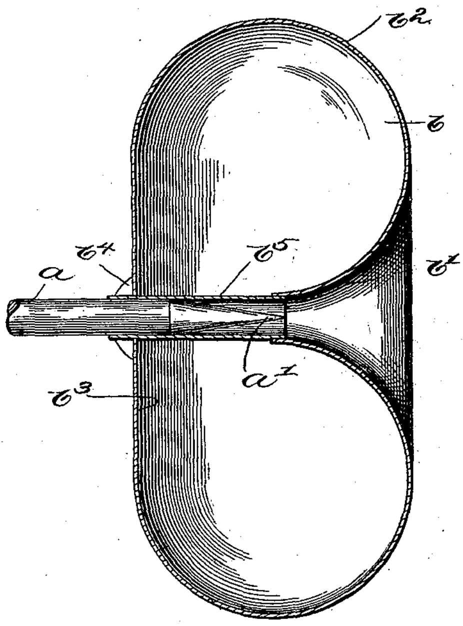


Fig. 3.



Witnesses.
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by Emery Gregory
Attys.

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UNITED STATES PATENT OFFICE.

THOMAS B. KINRAIDE, OF BOSTON, MASSACHUSETTS.

ELECTRODE.

SPECIFICATION forming part of Letters Patent No. 689,199, dated December 17, 1901.

Application filed May 2, 1901. Serial No. 58,511. (No model.)

To all whom it may concern:

Be it known that I, THOMAS B. KINRAIDE, a citizen of the United States, residing at Boston, county of Suffolk, State of Massachusetts, have invented an Improvement in Electrodes, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

My present invention is an electrode having for its object the regulation of the discharge effects or capabilities of the electrode.

As is well known, in certain situations of electrical discharge—as, for instance, in connection with the discharge-electrode of a Leyden jar—there is a tendency to continuous leakage, which prevents the full charging of the jar, and, again, it is sometimes desirable to check the brush-discharge—as, for instance, in an induction apparatus—especially when the two discharge-terminals are separated some distance, and also it is frequently convenient to be able to reverse the direction of discharge between two electrodes. Accordingly I have devised the hereinafter-described electrode for accomplishing, among other things, the above results, and in effecting my purpose I have availed myself of the principles set forth in my application, Serial No. 26,709, filed August 13, 1900, by combining the extensionless-point feature with the limitless-plane feature, as defined in my said application.

In the preferred construction of my present electrode I mount the point-discharge or discharge-rod adjustably in the center of the limitless plane, shaping the latter to correspond, so that it will maintain itself, electrically speaking, as a receiving plane or surface without edges or angular or pointed surfaces.

Further description of my invention and the operation thereof will be set forth in the following portion of the specification by reference to the accompanying drawings.

In the drawings, Figure 1 is a perspective view of my electrode. Fig. 2 is a vertical cross-section thereof. Fig. 3 is a view similar to Fig. 2, showing the electrode in a different adjustment.

It will be understood that my electrode is applicable to any conductor, the latter being herein indicated as a rod *a*, having at its forward end a point-discharge *a'*, formed integrally therewith. Mounted on the rod *a* just back of the point *a'* is the limitless-plane portion *b* of the electrode, herein shown as having a central inwardly-sloping curved surface *b'*, forming a bell-shaped mouth or opening, in the center of which is the point *a'*. The limitless-plane portion of the electrode extends from this central bell-shaped portion outwardly in such manner as to have no angular or pointed surfaces, being herein shown as curved around at b^2, substantially as shown in my before-mentioned application, the rear portion of the shell or surface extending at b^3 back to the rod *a* and being joined at b^4 to a tubular or sliding portion b^5 thereof. The purpose of this construction is to permit the point and surface to be moved relatively to each other so that the point may occupy an extended position, as shown in Fig. 2, or an intermediate position, as shown in Fig. 1, or a retracted position, as shown in Fig. 3, the portion *b* being in my present construction simply shoved backward or forward on the rod *a*. When the point projects forward, as indicated in Fig. 2, the electrode operates freely as a point-discharge; but when the parts are in the position shown in Fig. 3 the point is rendered inactive by reason of its inability to discharge past the extended surface *b*, which is charged with the same electricity as the point, this extended area of charged surface of like electricity repelling the discharge tendency of the point. Also by moving the two parts in one direction or the other a minimum or maximum charge or tendency to discharge may be maintained. For instance, as shown in Fig. 2, there is the greatest freedom of discharge, and this decreases as the shielding or screening influence of the limitless plane portion *b* is moved forward toward the point.

If, for example, my electrode is employed as a discharge-terminal of a Leyden jar and it is desired to check the brush discharge that takes place in the Leyden jar, causing the same slowly to "leak," as it is termed, all that is necessary is to move the surface *b* into screening position relatively to the point, thereby insuring a maximum charge of the jar. When thus charged, my electrode makes it possible to discharge the charge across a much greater air-gap by means of the screened point than is possible with simply usual discharge-terminals.

I have not undertaken to set forth in this specification all the uses to which my invention may be put, as it will be understood that it is applicable to a practically endless range of uses in connection with electrical apparatus.

Having described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. An electrode having a discharge-point, and means for electrically screening said point for limiting the tendency thereof to discharge.

2. An electrode having a discharge-point, and adjustable means for electrically screening said point for varying the tendency thereof to discharge.

3. An electrode having a comparatively fine point combined with a plane conducting-surface having its edges curved or rolled rearwardly and inwardly, and means for moving said surface relatively to said point.

4. An electrode having a plane conducting-surface shaped without edges or angular or pointed surfaces, combined with a point-discharge mounted within the area of said surface and projecting therefrom.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

THOMAS B. KINRAIDE.

Witnesses:
GEO. H. MAXWELL,
WILHELMINA C. HENSER.

N° 15,246 A.D. 1898

Date of Application, 12th July, 1898—Accepted, 10th Sept., 1898

COMPLETE SPECIFICATION.

Improvements in Automatic Break or Interrupter Apparatus for Electric Currents.

I, Thomas Burton Kinraide, of 38, Spring Park Avenue, Jamaica Plain, in the State of Massachusetts, one of the United States of America, Electrician, do hereby declare the nature of this invention, and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

It is the object of my invention to provide an improved automatic break or interrupter for electric currents, my invention being particularly adapted for use in interrupting the primary current of induction coils in connection with X-ray and kindred apparatus.

My invention secures high speed and accuracy of break, the successive breaks being rendered similar and synchronous, provides uniformity of wear of the make-and-break contacts, cures the irregularity and unsteadiness of the current hitherto so objectionable, increases the frequency, and gives uniform action of both current and apparatus under different resistances, besides simplifying and prolonging the life of the instrument.

As heretofore constructed, these instruments have had a break hammer carried on the free end of an ordinary leaf-spring vibrating between the core-end of an electro-magnet and a small contact or anvil, the latter being mounted on the end of an adjusting screw in the free end of a post or standard.

One serious drawback to these instruments has been that the speed of interruption, *i.e.*, the speed of the vibrations of the hammer, has been quite limited and there has been an unevenness of break.

I have found that these faults are due to a compound vibration of the instrument which tends to hasten some of the breaks and to retard others, and I have further found that this compound vibration, as I call it, may be obviated and that high speed may be attained and accurate breaks secured by providing an absolutely rigid and unyielding post or standard; as a result of this feature of my invention, the objectionable inaccuracy and unevenness of the breaks or interruptions dissappear, and a nicety of adjustment and compensation is feasible which would not otherwise be possible.

A further objection to the present old style of instrument, above mentioned, is that as the tension of the spring vibrator is increased to vary the electrical resistance of the break, the sparking of the instrument is increased, the current being also otherwise rendered irregular and uncertain, and I have discovered that this is due to the fact that in the adjustment of the vibrator the hammer is thrown more or less out of alignment with the core-end and anvil.

It is therefore one chief feature of my invention to provide means to maintain the hammer in proper accurate alignment with its core and anvil.

Again, irregularity and unsteadiness of current are due to the uneven wear of the contacting surfaces of the hammer and anvil, the intense heat of the constant arcing serving to fuse and batter down the said surfaces unevenly; and therefore I have

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mounted one of these surfaces on a rotatable spindle, so that the irregularities thereof may be automatically removed or obviated by rotating it as the hammer is vibrated.

In order still further to increase the efficiency of the break, I make the several parts thereof laminated, so as to get rid of the heating effects, thereby permitting the break to be extremely rapid.

In this connection also I provide a collector for the lines of force, thereby enabling a smaller hammer to be used with the effect of a large one.

Other advantages and features of improvement will be pointed out in the course of the following description of the details of construction.

In the drawings I have omitted all unnecessary details, confining the drawings to the details of improvement, and it will be understood that the latter may be used in connection with any suitable or preferred general style of apparatus.

Fig. 1 is an end elevation, partly broken away, showing one embodiment of my invention.

Fig. 2 is a top plan view thereof.

Fig. 3 is a broken detail in side elevation, showing a slight modification.

Fig. 4 is a side elevation of the collector, a portion of the hammer being shown in operative position.

Fig. 5 shows a detail of a modified collector.

Fig. 6 is a fragmentary detail in top plan, showing a rigid collector placed on the side of the hammer opposite the coil.

Fig. 7 illustrates one of the objectionable features of the old style instrument.

On a suitable base A is mounted a coil B supported by end supports c, c^1, herein shown as receiving the core b at its ends.

The hammer D, carried by a vibrator E, reciprocates between the core end b^1 and an anvil G, the hammer having a reduced end e held rigidly on the vibrator by a nut e^1.

Heretofore this vibrator has been a leaf-spring h, as indicated in Fig. 7, this spring being deflected more or less to the right when it has been desired to increase the electrical resistance offered by the hammer, the result being as shown in exaggerated form in Fig. 7, where it appears that the spring h when deflected to its dotted position inevitably upsets the hammer, so that the latter, when attracted to the core b^1, strikes the latter with its upper edge d^2 only, thereby increasing the resistance entirely out of proportion to that intended, and tending to burn or fuse the small point of contact d^2, also leaving a spark gap d^3, tending to ruin the hammer; the disastrous effects at the opposite end of the hammer being of the same sort excepting that the contact surfaces being smaller and composed of platinum, said effects are still more serious.

Accordingly, I obviate these disastrous results by making the vibrator E rigid and unyielding for most of its length, as shown at e^2, a short resilient section e^3 being preferably provided at its lower end next to the stud a, to which it is shown as fastened, and the necessary tension being secured by means of an auxiliary or tension spring K on the shank of an adjusting screw k, working at its threaded end in a post a^1 and journaled at k^1 in a standard a^2.

An adjustable thumb nut k^2 receives one end of the spring K, the opposite end bearing against the vibrator E which rides loosely over the screw rod k.

In this preferred form of mechanism for accomplishing my object, turning the screw k to the right or left correspondingly relaxes or tightens the spring K, thereby tending to move the vibrator E bodily forward to a greater or less extent to increase the number of amperes or quantity of current transmitted, and it will be noted that the hammer does not depend on the vibrator for its tension or resistance, but rather on the independent spring K, which bears centrally forward against the vibrator, the yielding section e^3 flexing readily, enough to permit the required movement forward of the rigid portion e^2.

I prefer to place the hammer at one side of the core, directly in the field of the greatest number of lines of force, the direction of the latter being indicated by arrows in Fig. 2, whereby the action of the apparatus is very materially improved; and in order still further to increase the frequency, and to get rid of the heating thereof, so that the brake can be extremely rapid, I make the several parts thereof laminated, as clearly shown, the core being preferably composed of a plurality of wires, and the hammer of a number of plates secured together, although any other means of lamination is within my invention.

In connection with the improved hammer, I provide means for positively limiting its movement, said means being herein shown as a projection or engaging lug e^4 on the vibrator cooperating with a stop e^5 preferably adjustable.

By reason of this construction the length of the spark gap between the hammer D and its anvil G is positively controlled, so that the time period of the interruptions may be regulated to the requirements of the circuit, for discharging the condenser at the proper moment to accelerate the inductive action of the primary of the induction coil with which we will suppose the apparatus is being used.

Adjacent the hammer and preferably above it I provide a collector L for the lines of force, to direct them upon the hammer, whereby a much smaller hammer may be used than would otherwise be possible for the same effect.

In Figs. 1, 2 and 4, this collector is shown as composed of a body of metal L, preferably soft steel or iron and laminated, placed within the field of force of the coil and immediately adjacent the hammer, thereby presenting to the hammer a field of strong magnetic intensity, so that it is equivalent to making the hammer much larger, at the same time permitting a much smaller moving part than usual.

Preferably this collector is movable relatively to the hammer, so that its effect on the latter may be varied, as indicated in Figs. 1—5, where the collector is shown as pivotted at *l* and as having its lower end convexly curved (Fig. 5) adjacent the hammer D, or internally formed to endorse said hammer (Figs. 1, 4).

By means of the collector the amount of current delivered through the break is readily controlled, inasmuch as the collector tends to gather in the lines of force and direct them to the hammer; so that if the collector is in the full line position, Figs. 1 and 5, the greatest intensity will result, whereas if the collector is in its dotted line position, a less intensity will result, and this may be varied according to the position into which the collector is swung, the resultant effect upon the hammer being that it has an active or sluggish movement according to the position of the collector.

When the collector is swung entirely away from the hammer or in case it is omitted entirely, the tendency of the hammer is to lag or hang to the anvil as it is drawn away, whereas with the collector in its full line position, as shown, the action of the break is short and quick.

The collector is shown as laminated, Fig. 5, showing it applied to a break having its hammer at the end of the core, while the other figs. show the collector applied to the special form of hammer forming part of my new break.

The configuration and position of the collector may be changed to include a greater or fewer number of the lines of force, or into the entire field, according to the effect it is desired to produce upon the hammer, one example being illustrated in Fig. 6 in which the collector L^1 is shown as mounted at the side of the hammer opposite the coil.

With this construction, whenever, by the tearing off of small pieces of the metal from the contact points, the break gap is partially short circuited when open, the rapidly increasing lines of force are so concentrated by the collector upon the hammer as to drag the latter sideways, toward the collector, thus overcoming the short circuit by shearing apart the fused particles and separating the points, the hammer then resuming its normal vibration.

It will be understood that as the hammer end *e* is pulled away from the anvil G, an arc is formed which inevitably fuses a slight portion of the opposing surfaces, and, as the breaks are rapid these surfaces, although platinum, are quickly rendered uneven.

Accordingly, I provide means to relatively rotate the meeting surfaces of the anvil and hammer, independently of the rotations due to the adjustments of said parts, the said means being herein shown as preferably consisting of a freely rotatable spindle g centrally mounted in a hollow adjusting screw g^1 having threaded engagement with an extended bearing a^3 in the standard a^4, being fixed in its adjustments by a check nut g^2.

The spindle g is rotated by a thumb wheel g^3 pinned on its outer end, and is held against longitudinal movement by a collar g^4 fixed near its inner end to abut against the inner end of the screw carrier g^1.

The spindle is threaded at g^5 to receive the anvil G the latter being shown in the form of a threaded cap provided with a required platinum contact, the platinum being soldered thereon, as indicated in heavy section lines Fig. 1.

The collar g^4 and anvil are made of a size to permit them to be withdrawn together, with the adjusting screw g^1, as the latter is screwed out of the standard a^4. It is understood that as the platinum points wear and fuse away the anvil is nicely adjusted forward by its screw carrier g^1 to compensate therefor.

Under the old construction the surfaces would fuse and wear unevenly, as explained, and then when it became necessary to adjust the anvil forward, it would be impossible because it would be found that the surfaces had become more or less interlocked, thereby preventing any relative rotation thereof, the result being that the apparatus was rendered useless until the anvil had been removed and the contacting surfaces carefully filed down, not only entailing loss of time but loss of the platinum.

According to my invention the adjusting movement is entirely independent of any rotation of the anvil.

In order to give the most efficient work, the breaks should not only be exceedingly rapid, but they should be even or accurate in synchronism.

Accordingly, I have rendered the standard, which supports the anvil, absolutely rigid and non-vibrant, finding as a result that the accuracy of break which is sought is thereby attained, and that the speed or note of vibration is raised, this being due to the prevention of compound vibrations.

I prefer to render the standard thus rigid by interposing a bar or brace M, Figs. 1 and 2, or M^1, Fig. 3, of insulating material between opposite posts of the frame, this bar being let into the frame and held rigid by said screws, the object being to prevent the standard, and hence the anvil, from being responsive to the vibrations of the hammer, and thereby occasioning a compound or confused vibration or interruption of the current.

Various modifications and details of mechanisms may be used to embody my invention.

Having now particularly described and ascertained the nature of my said invention, and in what manner the same is to be performed, I declare that what I claim is:—

In an automatic break or interrupter for electric currents:—

1. A high speed break, comprising a coil and its core, an anvil in electric circuit with said coil, a standard supporting the anvil, and means to render said standard absolutely non-vibrant, whereby compound vibrations are prevented and the speed is increased, substantially as described.

2. A high speed break, having a hammer vibrating between a core-end and an anvil, means to vary the vibrating resistance of said hammer, and means to maintain said hammer in approximately unvarying end alignment with said core-end and anvil, substantially as described.

3. A high speed break, a hammer, a vibrator supporting the same, and an adjustable tension device to vary the resistance of said hammer, said vibrator having an extended rigid portion extending from said hammer, substantially as described.

4. A high speed break, a hammer, a vibrator supporting the same, and an adjustable tension device to vary the resistance of said hammer, said vibrator having an extended rigid portion extending from said hammer and being provided at its

opposite end with means to permit said rigid portion to be deflected slightly, substantially as described.

5. An electric break, having a hammer vibrating against an anvil, and means to adjust the latter, means to rotate said anvil independently of its said adjustment, substantially as described.

6. An electric break, the combination with a hammer, its anvil, and a hollow adjusting screw for the latter, of a spindle carrying said anvil and rotatably mounted therein, substantially as described.

7. The herein described anvil, the same consisting of an interiorly threaded cap, and a centrally extended platinum contact integrally secured thereon, substantially as described.

8. The combination with an electric break having an electro magnet, an anvil, and a vibrating hammer, of a collector to concentrate the lines of magnetic influence on said hammer, substantially as described.

9. The combination with an electric break having an electro-magnet, an anvil, and a vibrating hammer, of a collector to concentrate the lines of magnetic influence on said hammer, and means to vary the position of said collector relatively to said hammer, substantially as described.

10. The combination with an electric break, having an electro magnet, an anvil, and a vibrating hammer, of means to shear or drag sideways the hammer from the anvil whenever the break-gap between the hammer and anvil is partially short circuited by the fusing or clinging of the metal at the contact points, substantially as described.

11. An electric break of the vibrator class, provided with a hammer composed of laminated material, substantially as described.

12. An electric break, a core, a hammer, and collector, to concentrate the lines of magnetic influence on the hammer, said collector being composed of laminated material, substantially as described.

13. The combination with an electric break, having an anvil and a vibrating hammer, of a positive stop to limit and positively stop the movement of the latter from the anvil, substantially as described.

Dated the 9th day of July 1898.

WM. BROOKES & SON,
55 & 56. Chancery Lane, London,
Agents for the Applicant.

Redhill: Printed for Her Majesty's Stationery Office, by Malcomson & Co., Ltd.—1898.

A.D. 1898. JULY 12. Nº 15,246.

KINRAIDE'S COMPLETE SPECIFICATION. (1 SHEET)

Fig. 1

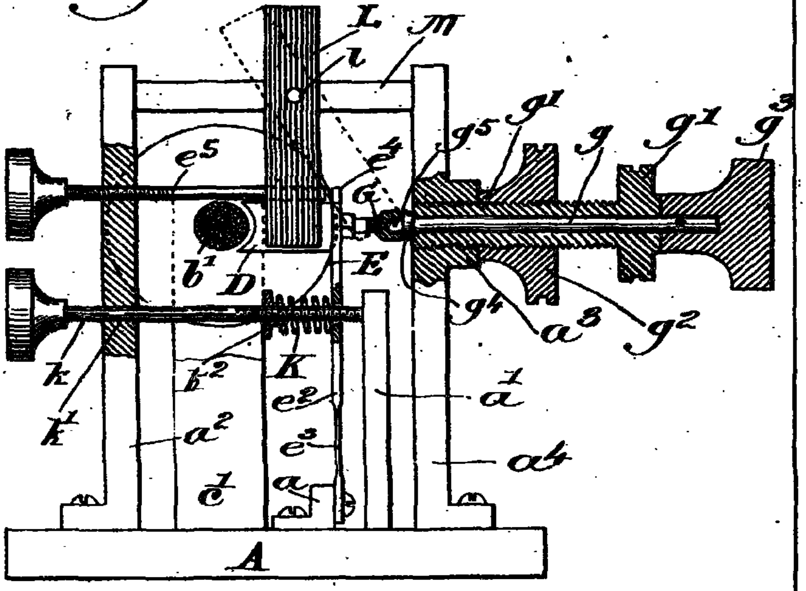


Fig. 4

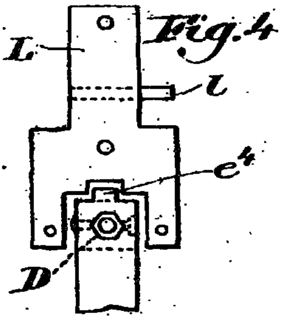


Fig. 6

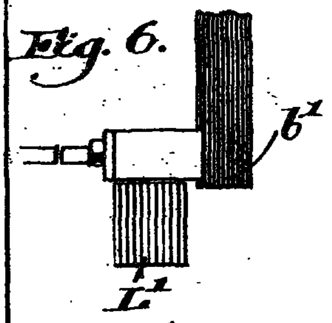


Fig. 2.

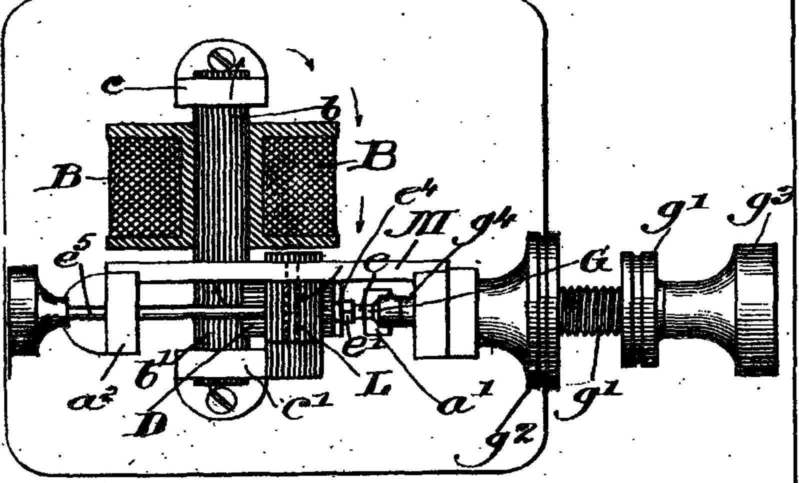


Fig. 5.

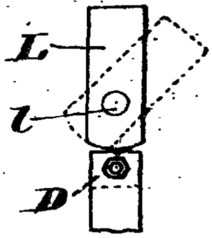


Fig. 7

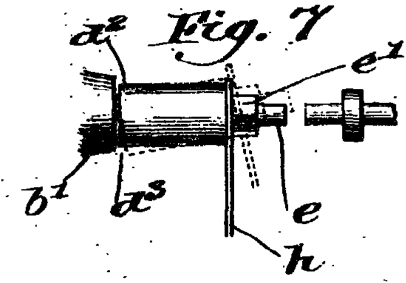
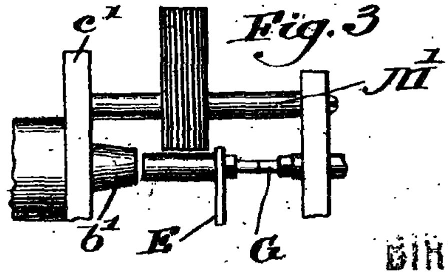


Fig. 3



[This Drawing is a reproduction of the Original on a reduced scale.]

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Malby & Sons, Photo-Litho.

N° 5518 A.D. 1899

Date of Application, 14th Mar., 1899—Accepted, 8th July, 1899

COMPLETE SPECIFICATION.

Improvements in Electric Spark Gap Apparatus.

I, THOMAS BURTON KINRAIDE, of 38, Spring Park Avenue, Jamaica Plain, in the State of Massachusetts, one of the United States of America, Electrician, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

The more recent developments in electrical matters, and particularly in the line of experimental research in connection with static electricity, has developed conditions requiring the discharge of such enormous potentials and amperage as to render the apparatus heretofore provided for such purposes inefficient and largely useless, for the reason that these enormous discharges which the electrician frequently desires to experiment or deal with very quickly render inoperative or destroy such usual apparatus.

Accordingly, it is the object of my present invention to provide a practically indestructible discharge apparatus to meet the more exacting requirements of the present day, and to that end I provide a spark gap which is virtually self-recuperative, and comprises opposite parallel discharge surfaces of considerable area, which, besides their practically indestructible character, possess numerous very important advantages all as will be more fully pointed out in the course of the following detailed description of the apparatus, reference being had to the accompanying drawings illustrative of preferred embodiments thereof.

In the drawings, Fig. 1 represents in side elevation a simple form of my improved spark gap.

Fig. 2 is a similar view shewing a modification.

Fig. 3 is a top plan view of the form of apparatus shewn in Fig. 2.

I provide electrodes preferably in the form of opposite parallel discs g, g^1, the air gap between whose frame surfaces constitutes the spark gap, the extended area of these electrodes preventing the tendency of the condenser (for example) with which my invention will ordinarily be used, to discharge until it has reached its maximum charge, and also causing the discharge to be exceedingly sudden when it does take place, and the discs not being liable to become unduly heated.

The spark gap constitutes virtually a self-recuperative condenser, as it were, the parallel, and preferably plane, metallic surfaces g, g^1, being the discharge surfaces which discharge through or across the intervening air dielectric. The air gap is broken through when the voltage has exerted a sufficient strain upon the air to rupture it. The larger the discs are, the greater condenser capacity will they have, and hence the further apart they will spark.

At each discharge of the condenser a small portion of the plates g, g^1, is oxidized, the successive discharges producing very thin oxidation here and there until the entire surfaces of the two discs are completely oxidised. These discs may be made of copper or other suitable conductor material.

Suitable means is provided for accurately adjusting these plates relatively to each other and regulating their distance apart, or, in other words, for controlling the resistance of the intervening gaseous dielectric, and referring to the drawings, where-

[*Price* 8*d*.]

I have shewn a preferred means for accomplishing my object, it will be seen that I provide a plurality of posts g^2 threaded at their upper ends and carrying shouldered nuts g^3 on the shoulders of which is placed the top disc g^1.

The opposite plate g rests on a support or table g^4 and is mounted loosely on a post g^5, being normally held downwardly by a spring g^6 contained in a hanger or housing g^7 depending from the table g^4 said spring bearing at one end against the flanged lower end of the hanger g^7 and at its other end bearing against a washer g^8 retained by a screw g^9 whose head enters a hole or recess in the plate g for centering the latter.

The plate g is provided on its underside with a plurality of recesses or sockets, herein shewn as three in number, which receive props or struts g^{10} projecting upwardly from the base of the instrument.

These props g^{10} are of precisely equal length, so that they support the plate g in absolute parallelism to its opposite plate g^1.

The support g^4 has depending from its lower side a stud g^{11} which is engaged by the bifurcated end g^{12} of a lever g^{13} pivoted at g^{14} to a post g^{15} on its base.

By this provision the most delicate adjustment is possible simply by swinging the lever g^{13} one way or the other so as to incline the struts g^{10} more or less, and thereby increase or decrease the distance between the plates g, g^1, the nuts g^3 being depended upon for the coarser adjustments of the plates.

In Figs. 2 and 3 I have shewn the plates g, g^1, as hollow and provided with water circulation pipes g^{16}, in order that they may be absolutely prevented from all heating under extraordinary conditions.

Under usual conditions, however, this provision is entirely unnecessary, it being sufficient simply to provide the plates as shewn in Fig. 1.

When the adjacent surfaces of the plates have become entirely oxidized, the plates may be turned over and their opposite sides used, and when both sides have become oxidized, they may be readily removed and scoured off without destroying any of their adjustments.

My apparatus makes possible the sudden discharge of a condenser after the latter has reached a certain predetermined point, and said discharge is of great volume or large amperage and of a very sudden and abrupt nature, as the current will not break across the spark gap until it cannot help doing so, and when it does do so the discharge takes place with a minimum heating effect, not interfering with the efficiency, with very rapid and with very short and sharp oscillations incapable of being obtained between a ball or point discharge gap.

The adjustment of the plates relatively to each other regulates the amperage discharge of the instrument being discharged.

Having now particularly described and ascertained the nature of my said invention, and in what manner the same is to be performed, I declare that what I claim is:—

1. A spark gap of the kind described, said spark gap presenting opposite parallel discharge surfaces of relatively large areas, and means for regulating the discharge distance between said parallel surfaces, substantially as described.

2. The herein described spark gap comprising opposite electrodes presenting parallel discharge surfaces, one of said electrodes being supported on three or more struts of equal length, and means for rotating said strut-supported electrode about its centre, whereby its adjustment may be varied to and from the opposite electrode, substantially as described.

3. A spark gap comprising two permanent large superficial areas parallel to each other, constituting opposite discharge surfaces, and an interposed gaseous dielectric, said discharge surfaces having condenser capacity for breaking down the intervening dielectric, and the latter automatically restoring or renewing itself, substantially as described.

4. A spark gap comprising opposite hollow plates or discs having parallel discharge surfaces, means for regulating the discharge distance between said surfaces, and

circulation pipes entering the same, whereby a circulation of water may be maintained for keeping the plates or discs cool, substantially as described.

5. A spark gap comprising three or more posts, shoulders adjustable thereon, a plate or disc supported on said shoulders, a second plate below the same, a support therefor, three or more upright struts loosely engaging said support, and means to rotate said support about its centre, whereby said struts are simultaneously and similarly moved for varying the distance apart of said plates, substantially as described.

6. A spark gap comprising a central post, a plurality of supporting posts, two plates, one carried by said supporting posts and the other adjacent said central post, three or more similar struts supporting said lower plate, a spring maintaining said struts in proper supporting relation, and means to rotate the lower plate on said central post, substantially as described.

7. A spark gap comprising a plurality of supporting posts, two plates, the lower plate being pivotally mounted, three or more similar struts supporting said lower plate, and the upper plate being supported by said supporting posts, a lever pivotally mounted adjacent said lower plate and loosely connected therewith at its inner end for rotating said plate and tipping said struts, substantially as described.

8. A spark gap comprising a central post, a plurality of supporting posts, two plates, the lower plate being pivotally mounted concentrically to said central post, a hanger depending adjacent said post, a spring between said post and hanger and engaging the hanging at its lower end and held by the post at its upper end, three or more similar struts supporting said lower plate, and the upper plate being supported by said supporting posts, a lever pivotally mounted adjacent said lower plate and loosely connected therewith at its inner end for rotating said plate and tipping said struts, substantially as described.

Dated the 14th day of March 1899.

WM. BROOKES & SON,
55 and 56, Chancery Lane, London, Agents for the Applicant.

Redhill: Printed for Her Majesty's Stationery Office, by Malcomson & Co., Ltd.—1899.

A.D. 1899. MARCH 14. N° 5518.

KINRAIDE'S COMPLETE SPECIFICATION. (1 SHEET)

Fig. 1.

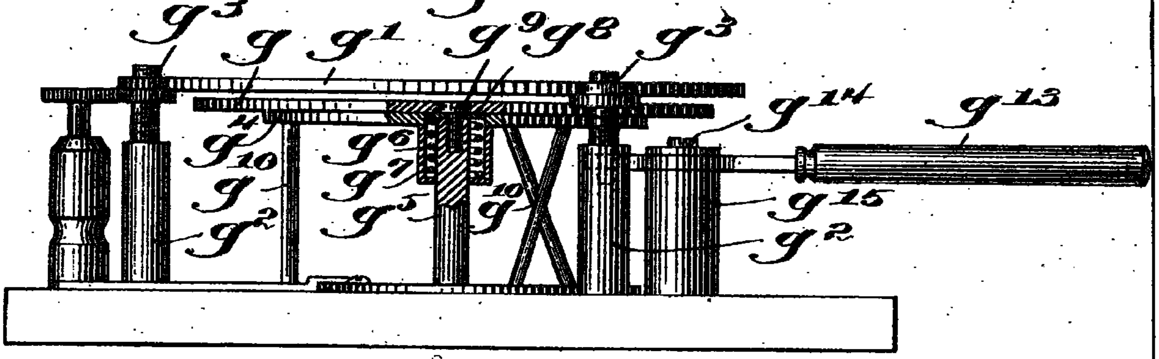


Fig. 3.

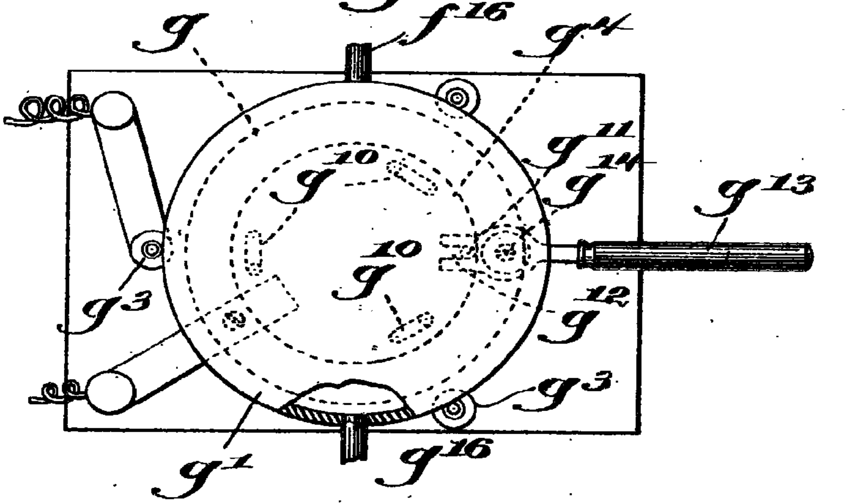
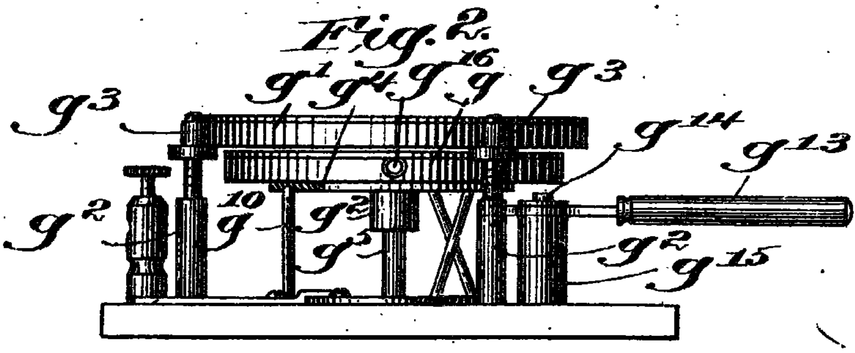


Fig. 2.



[This Drawing is a reproduction of the Original on a reduced scale]

Malby & Sons, Photo-Litho.

N° 5519 A.D. 1899

Date of Application, 14th Mar., 1899--Accepted, 15th Apr., 1899

COMPLETE SPECIFICATION.

Improvements in Electric Break Apparatus.

I, Thomas Burton Kinraide, of 38, Spring Park Avenue, Jamaica Plain, in the State of Massachusetts, one of the United States of America, Electrician, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

Electric breaks as heretofore provided have been subject to considerable sparking, which is not only destructive of the apparatus but is very objectionable in its effects on the current and system being operated, this being especially true of rotary breaks which operated by means of a brush in frictional engagement with a rotating surface.

Accordingly I have invented a break in which there is no chance for arcing as there is no surface to arc over, and also a leading object of my break is to provide a means for making an exceedingly quick break with a relatively long period of closed circuit, my break rendering it possible to regulate the period of closed circuit accurately.

In the drawings Fig. 1 is a top plan view of one form of my break.

Fig. 2 shows the same in elevation.

On a suitable base D I journal in a central post or bearing d a spindle d^1 of an iron plate or armature d^2, having two or more regions of varying mass of magnetic material, herein shown in the form of eccentric edges d^3, as clearly shown in Fig. 1.

My object is to provide regions of increasing magnetic attraction to cooperate with one or more suitable electro magnets or solenoid devices, so located as to successively attract these regions of varying mass of magnetic material, for rotating the armature, as will now be explained.

Mounted on or otherwise connected to rotate with the armature d^2 are one or more small antifriction rolls d^4, two being herein shown mounted at the opposite ends of a bar d^5 clamped adjustably on the plate d^2.

These rolls or circuit interrupters are preferably of indurated fibre.

Mounted to extend into the path of the rolls d^4 is an arm shown as a wire d^6 carrying a hammer d^7 to contact with an anvil d^8 on a post d^9, and limited in its movement by a fibre stop d^{10} on the end of an adjusting screw d^{11}.

The wire d^6 is carried by a hub d^{12} loose on a pin d^{13} and held under tension by a spring coil d^{14}, Fig. 2, fastened at one end to said hub and at its other end to a nut d^{15} carrying an adjusting or set screw d^{16}; so that by loosening the set screw and swinging its handle one way or the other the resistance of the arm d^6 may be varied.

Preferably adjacent the periphery of the armature d^2, I place attracting means,

[*Price* 8*d*.]

herein shown in the form of solenoids or electro magnets d^{17}, d^{18}, connected with the main or other source of current by wires d^{19}, which enter the solenoids at their inner terminals, so that as the magnets d^{17}, d^{18} are energised, they attract the armature or plate d^2, and by the increasing pull exerted thereon, on account of the eccentric surfaces d^3, they cause the plate to rotate with a speed only checked by the striking of the interrupters d^4 against the end of the arm d^5, said rolls being placed relatively to the highest points of the surfaces d^3, so that they cut off the current just before said highest points get opposite the propelling magnets, thereby permitting the momentum of the plate or armature d^2 to carry said highest points beyond the magnets sufficiently to prevent the latter exerting any retarding influence on the rotation of the break.

Preferably I mount the anvil and hammer on a swinging ledge or carrier d^{20}, journaled on the post d, so that I am enabled to regulate the speed of the break simply by swinging the carrier d^{20} one way or the other.

The same effect may be obtained by shifting the roll or rolls d^4 on the plate d^2, provided they are carried, as preferred, on a bar d^5, so that they can be shifted.

This adjustment cannot of course take place while the apparatus is in operation, and therefore for instantaneous regulation of the apparatus I provide the swinging carrier d^{20}.

A movement of the carrier from right to left causes the current to be broken before the armature has reached its point of greatest attraction, and as it is moved further toward the left, the pull on the armature exerted by the magnets is diminished more and more, and the speed of rotation of the armature is correspondingly reduced, thereby reducing the number of breaks, and at the same time lengthening the time which the circuit being interrupted is closed.

I place the arm or wire d^6 slightly tangential to the armature, as will be seen viewing Fig. 1, in order that the rolls d^4 may strike the extreme end thereof with least friction, striking outward instead of square against the end.

The arm d^6 is connected to the main or branch therefrom, at d^{21} by means of any suitable conductor d^{22}, and the anvil d^8 has a connection d^{23} to the delivery end d^{24} of the circuit as will readily be understood.

In operation the magnets being energised attract the eccentric surfaces or other varying masses of magnetic material so as to cause the armature to rotate over to the left, Fig. 1, the circuit being completed at d^7, d^8, until the very moment when the interrupter d^4 strikes the free end of the arm d^6, whereupon the circuit is instantaneously broken and as this time occurs slightly before the highest points, or places of greatest attraction of the armature, come opposite the solenoids, the latter are rendered inactive merely during the moment when the momentum of the armature is carrying the latter by the solenoids so as to bring the region of least magnetic mass again opposite the solenoids in position for the latter, upon becoming active by the making again of the circuit, to renew their pull upon the armature and thereby continue its rapid revolution.

This action is rapidly repeated at every make and break of the instrument.

I prefer to provide opposite solenoids in order to render the device perfectly balanced and smooth running, although it will be understood that variations in this and in all other details of my invention may be made.

By the use of my invention the time period of closed circuit may be made as considerable as desired.

With any usual break this would be impossible for the reason that in order to give an equivalent period of closed circuit the brush would of necessity remain upon the surface of the break so long as to heat frictionally the surfaces so as to produce a constant arc, ultimately destroying the break as well as the efficiency of the circuit.

In my break there is not only no chance for it to arc, as there is no surface for it to arc over, but the break itself is so exceedingly quick that there is not even a spark at the time of break, but there is merely occasionally a residual spark upon the closing of the break, Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. An electric break comprising a rotating member, an electro magnet, a break device, and means driven by said rotating member for interrupting said break device, said rotating member presenting a surface of attraction to said magnet eccentric to the centre of rotation of said member, substantially as described.

2. An electric break comprising a rotating member, an electro magnet, a break device, and means driven by said rotating member for interrupting said break device, said rotating member presenting a surface of attraction to said magnet eccentric to the centre of rotation of said member, and means for varying the time of interruption of said break device relatively to the point of highest attraction of said eccentric surface, substantially as described.

3. An electric break comprising a rotating member, an electro magnet, a spring, a break device, means to vary the resistance of said break device, and means driven by said rotating member for interrupting said break device, said rotating member presenting a surface of attraction to said magnet eccentric to the centre of rotation of said member, and means for varying the time of interruption of said break device relatively to the point of highest attraction of said eccentric surface, substantially as described.

4. An electric break comprising a rotating member having regions of varying mass of magnetic material producing regions of increasing magnetic attraction, an electro magnet adjacent said rotating member, a break device, and an interrupter driven by said rotating member for interrupting the break device, substantially as described.

5. An electric break comprising a rotating member having regions of varying mass of magnetic material producing regions of increasing magnetic attraction, an electro magnet adjacent said rotating member, a break device, and an interrupter carried by said rotating member for interrupting the break device, substantially as described.

6. An electric break comprising a rotating member having regions of varying mass of magnetic material producing regions of increasing magnetic attraction, an electro magnet adjacent said rotating member, a break device, and a pivoted roll carried by said rotating member for interrupting the break device, substantially as described.

7. An electric break comprising a rotating member having regions of increasing magnetic attraction, an electro magnet adjacent said rotating member, a break device, and a pivotted roll carried by said rotating member for interrupting the break device, and means for adjusting said roll on said rotating member, substantially as described.

8. An electric break comprising a rotating member having regions of increasing magnetic attraction, an electro magnet adjacent said rotating member, a break device, and a bar fixed on said rotating member and provided with rolls pivotted thereon at its opposite ends in line with and to interrupt said break device, substantially as described.

9. An electric break comprising a rotating member having regions of increasing magnetic attraction, an electro magnet adjacent said rotating member, a break device, and an interrupter carried by said rotating member for interrupting the break device, said break device being mounted on a carrier movable concentrically to said rotating member, substantially as described.

10. An electric break comprising a rotating member having regions of increasing magnetic attraction, an electro magnet adjacent said rotating member, a break device, and a revolving interrupter driven by said rotating member, said break device including a yielding arm projecting obliquely into the path of said interrupter, substantially as described.

11. An electric break comprising an arm carrying a hammer, an anvil opposite said hammer, said arm being yieldingly supported and provided with means for

regulating the tension or resistance thereof, an interrupter for engaging the free end of said arm, and automatic means operated by the current being broken for driving said interrupter, substantially as described.

Dated the 14th day of March 1899.

WM. BROOKES & SON,
55 & 56, Chancery Lane, London, Agents for the Applicant.

Redhill: Printed for Her Majesty's Stationery Office, by Malcomson & Co., Ltd.—1899

A.D. 1899. March 14. N^{o} 5519.

KINRAIDE'S Complete Specification.

(1 SHEET)

Fig.1.

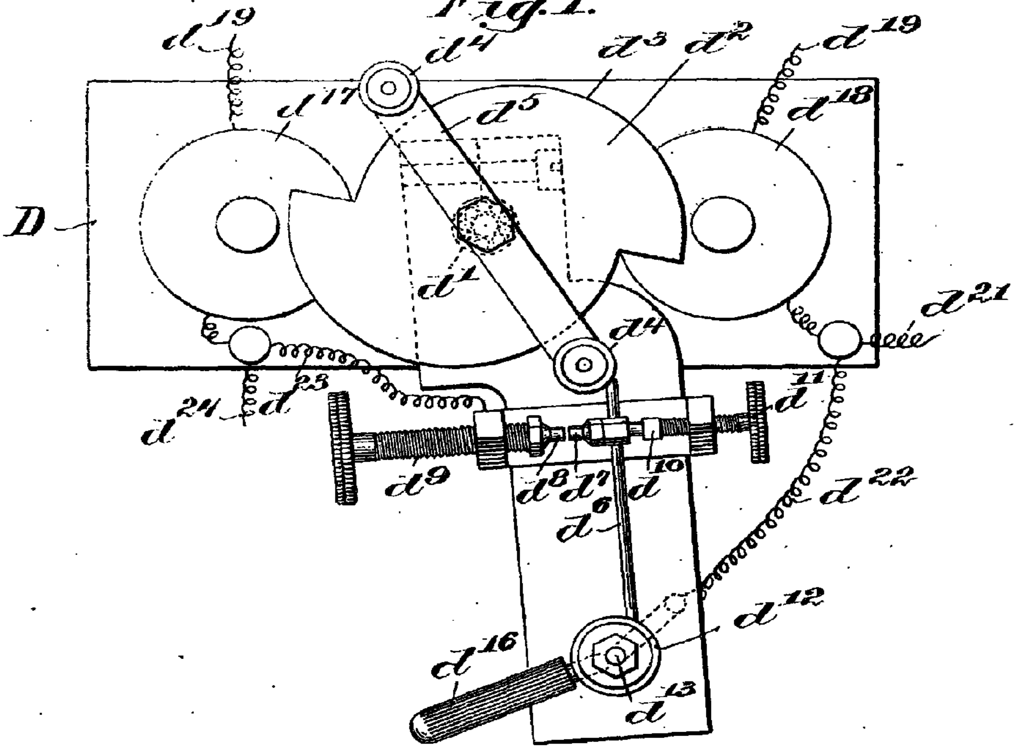
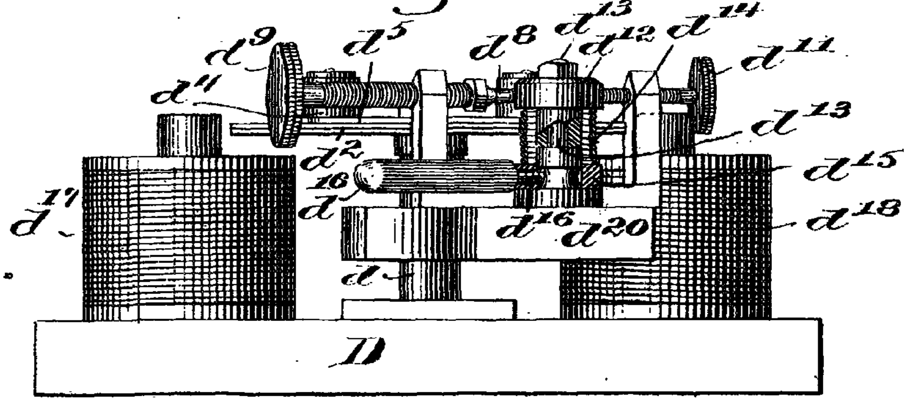


Fig.2.



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Malby & Sons, Photo-Litho.

N° 12,408 A.D. 1901

Date of Application, 18th June, 1901—Accepted, 20th July, 1901

COMPLETE SPECIFICATION.

Improvements in and relating to Static Rectifiers and other Electrical Apparatus for Producing or Maintaining Continuous or Unidirectional Discharges

I THOMAS BURTON KINRAIDE, of 38 Spring Park Avenue, Boston, State of Massachusetts, one of the United States of America, Electrician, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention is shown as embodied in an electrical machine of the kind known as static rectifiers, but the invention considered in its broader features is not restricted to this particular electrical machine, but is of wide application to various kinds of electrical apparatus, and embodies certain important discoveries which I have made, whereby I am enabled to positively maintain an electrical discharge in one direction only, and under proper conditions to maintain said discharge continuously, producing, for instance, without the intervention of a commutator, a continuous current, directly from an alternating or intermittent current.

Without necessarily stating that such is the fact, it may be supposed that there is simply electrical energy and that the presence of said energy is what we call a positive condition, and the absence of said energy is what we call a negative condition, and this, taken with my discovery that electric energy in its positive condition discharges reluctantly from a plane (without edges, or angular or pointed surfaces) and discharges with perfect freedom from a point, enables me to control the direction of discharge of the current and hence the accumulation of potential.

The requisite conditions are provided by means of what I term an extensionless point which provides, as nearly as it can be done mechanically, the ideal discharge electrode or positive condition for the outward flow of the electrical energy, and by means of what I term a limitless plane which provides in the same manner the receptive electrode or negative condition in which there may be said to be an absence of energy (or a lower potential than that of the point from which the discharge comes), analogous to a vacuous condition or absence of electrical pressure.

By this means, the electrical energy tends to discharge continuously in one direction only, *viz* : from the extensionless point to the limitless plane.

I have applied my invention in various ways, as, for instance, in a static machine in which the receiving electrode has an extended plane surface or large flat area of the limitless plane type and the discharge electrode has a point discharge or preferably a series of points like a usual cone; but for the purposes of fuller explanation of my invention as well as being covered by certain of the claims in this application, I have illustrated my invention more elaborately in an electrical apparatus for producing unidirectional discharges of high potential.

In the drawings Fig 1 is a view, partly in perspective and largely diagrammatic, of one form of machine embodying my invention;

Fig 2 is a vertical cross-sectional view showing the most approved form of two of the cooperating electrodes;

Fig 3 illustrates the application thereof for transforming an intermittent current into a constant current;

[*Price* 8*d*.]

Fig 4 illustrates the application of my invention to Leyden jars for converting an intermittent discharge into a continuous discharge.

Referring now more particularly to Fig 2, in order that the foundation idea of my invention may be first clearly understood, it will be seen that the electrode *a* is pointed or pencil shaped and that the extreme discharge point *b* is in or projected slightly through a small aperture *c* in a rubber or other flat disc *d* which extends at right angles thereto, the purpose of this disc being to cut off the attracting area which would otherwise be present in the converging walls or surfaces of the electrode *a*.

By this means I provide an extensionless point, speaking electrically. By this term, I mean a point in which the attractive area of the electrode relatively to the opposite electrode is limited to the point itself or, in other words, in which the rubber disc *d* shields all the surface of the rod or electrode behind the very point thereof.

The rubber disc constitutes means for cutting off the receptive area about the discharge point.

Opposite the electrode point *b* is the receptive electrode *e* which maintains a negative condition relatively to the electrode *a*, and which I have termed the limitless plane, speaking again electrically, this electrode having a large receptive area and being provided with means for preventing the tendency to discharge, said means residing in presenting a receptive surface or plane without angles or points, and this plane is secured by providing a flat surface *f* of considerable relative extent and curving its edges back and inwardly as indicated at *g*, whereby, viewed electrically, the surface is limitless inasmuch as it has no termination within the influence of the discharge point *b*.

In operation, the positive energy discharges invariably from the point *b* to the plane *f* and there is no discharge from the latter back to the point, one reason therefor being that the attraction of the limitless plane is compelling, there being practically no attraction in the opposite direction, due to the shielded point.

From the foregoing the extensionless point and limitless plane feature, which is at the basis of my invention, will be readily understood, and it will be seen that its field is important and large.

For example, in Fig 3 I have indicated a typical source of intermittent or alternating energy in the form of an induction coil *h* (operated by an alternating current) whose terminals *i*, *j*, are provided with electrodes *a*, *e*, of the kind already described, and opposite these electrodes which are arranged in pairs are complementary electrodes *e a*, connected to a working circuit *k* which it is desired shall have a continuous current.

Remembering that, as already explained, the extensionless point and limitless plane electrodes compel the discharge to take place in one direction, it will be seen that the intermittent or alternating discharge from the coil *h* is automatically transferred into a continuous current by the lower sets of electrodes as arranged in Fig 3.

Referring now to Fig 1, where I have shown a more complete machine constructed to employ my invention in an elaborate manner, I have mounted on suitable insulating posts 2 a series of these electrodes *a*, *e*, arranged in opposite sets, there being herein shown three pairs in each set, on opposite sides of the machine.

On the right hand side of the machine the point electrodes are mounted in a rail 3 and screened by a shield 4 (although they may be screened by any other suitable means, as may be convenient, and, in fact, the machine will operate to advantage for some purposes without any screen), and the plane electrodes are mounted in a conductor rod 5, while on the opposite side of the machine the arrangement is reversed, the plane electrodes *e* being mounted in the rail 3, and the point electrodes in the rod 5.

In a suitable position, herein shown as the end of the right hand rod 5, is mounted a point electrode a^1, and opposite thereto mounted in the opposite rod 5 is a plane electrode e, while suitably connected thereto is any form of apparatus with which it may be desired to use the machine, herein shown as a condenser 6 connected by wires 7, 8, to the conductor rods 5.

On the base or table 9 are carried a plurality of high potential generating units, as they may be called, herein shown as usual induction coils 10, 12, 13, the terminals of whose secondaries are connected respectively to the lower set of electrodes immediately above them, as is clearly shown, and whose primaries are connected to a battery or other current source 14, an interrupter m being interposed in the circuit and a series of condensers 15, 16, 17, being properly interposed.

The condensers may be thrown into the circuit, as may be desired, by switches n, n^1, n^2.

While the machine will work with other forms of interrupters, yet for the best efficiency thereof I have found it necessary to employ a special interrupter consisting of a cup m^1 provided with a quantity of mercury m^2, above which is a bath of kerosene oil m^3.

A fixed conductor m^4 from the interrupter m leads into the mercury, and above the same is arranged a series of plungers or contact makers m^5, m^6, m^7, connecting respectively with the several high potential units 10, 12, 13, and operated by a shaft m^8 driven by any suitable means, as by a motor m^9, belt m^{10} and pulley m^{12}.

On the shaft m^8 are eccentrics m^{13} relatively adjustable by means of set screws m^{14}.

I have described my mechanism in all its preferred details of construction, as herein embodied, but it will be understood that many changes and substitutions may be resorted to without departing from the spirit and scope of my invention, and that the form and general make up of the apparatus will usually be modified to conform to the particular situation and purpose for which it is intended.

The operation is as follows When quantitative effect of discharge is desired, the interrupter is set as shown, the eccentrics all being placed the same, so that the coils are all broken simultaneously, the coils being in multiple, and thereby the lower electrodes a at the right hand, simultaneously discharge their respective coils, and this combined discharge is received by the opposite electrodes e and conveyed by the conductor 5, thereby giving an enormous discharge from the point a^1 to the receiving electrode e^1, the circuit being completed therefrom through the upper electrode a to the electrode e, and meanwhile the condenser 6 is charged, according to its capacity.

If, on the other hand, continuity of discharge is desired, the eccentrics m^{13} are adjusted in step with each other, so that the interruptions in the mercury cup are made dissimultaneously, or in succession, thereby discharging the coils 10, 12, 13, successively, and hence producing a continuous discharge between the electrodes a^1, e^1, this discharge being at a given voltage, according to the capacity of the condenser 15, 16, 17, or such part thereof as may be used.

By having a plurality of induction devices or high potential generators arranged in step in connection with the point and plane electrodes, I am enabled to obtain a continuous discharge, yet employ a slow interruption, the result being that a maximum output is made certain.

This result has not heretofore been feasible, as it would be necessary to operate the interrupter with great rapidity in order to get the high potential required, and when the interruptions of a coil are exceedingly rapid the output from the secondary, as is well known, is below its capacity.

This invention makes possible obtaining a purely direct discharge, *i.e.*, free from oscillations, such as has heretofore been obtained only from a static machine; accomplishes the handling or control of any quantity, however great, of high potential current; is a most powerful generator for X-ray work, and ideal in its control of the quality of X-rays, on account of the discharge being wholly in one direction, continuous, and from a condenser; besides various other advantages which will occur to those skilled in the art.

In Fig 4 I have illustrated my electrode invention applied to two Leyden jars 18 having their outer coatings electrically connected by a wire 19 and their inner coatings connected by posts *p* in which are mounted usual discharge rods *r*, said posts, however, being provided on their upper extremities with the electrodes *a*, *e*; opposite to electrodes *e*, *a*, at the terminals of a coil *h* (operated by an interrupted current).

By this means, it is possible to maintain constant discharge at an approximately fixed potential similar to the discharge from a static machine, as the intermittent discharge from the induction coil which is the source of supply for the Leyden jars, is enabled to keep the Leyden jars at a practically saturated point, so that the latter can maintain a constant discharge between their rods *r*.

Having now particularly described and ascertained the nature of my said invention, and in what manner the same is to be performed, I declare that what I claim is:—

1. The herein described means for producing a continuous or unidirectional discharge, consisting of electrodes one of which has a discharge point and is provided with means for cutting off the receptive area about said point, and another of which has a large receptive area provided with means for preventing the tendency to discharge, as set forth.

2. An electrode terminating in a plane conducting surface, having its edges curved or rolled rearwardly and inwardly.

3. An electrode terminating in a comparatively fine point, and a flat shield extending approximately at right angles to said electrode and having a small aperture in which said point is located.

4. In an electrical apparatus, a source of intermittent electrical energy having at its opposite terminals electrodes one of which has a discharge point provided with means for cutting off the receptive area about said discharge point and the other of which has a large receptive area provided with means for preventing the tendency to discharge, said means residing in presenting a receptive surface without angles or points, and other electrodes cooperating with said terminal electrodes, there being a discharge point electrode arranged to cooperate with a receptive area electrode and *vice versa*.

5. An electrical apparatus, comprising a plurality of high potential generating units, and means uniting them in a unidirectional discharge.

6. An electrical apparatus, comprising a plurality of high potential generating units, means for giving them a unidirectional discharge, and mechanism for discharging them simultaneously or dissimultaneously, as desired.

7. An electrical apparatus, comprising a plurality of induction coils whose secondaries have at one end a point electrode, and at the other end a plane electrode, cooperating electrodes therefor, and a condenser and interrupter in the circuit of the primaries of said coils, said interrupter comprising a mercury cup having a series of movable contact makers movable in oil above said mercury

8. An electrical apparatus, comprising a plurality of induction coils whose secondaries have at one end a point electrode, and at the other end a plane electrode, cooperating electrodes therefor, a condenser and interrupter in the circuit of the primaries of said coils, said interrupter comprising a mercury cup having a series of movable contact makers movable in oil above said mercury, and means for varying the movement of said contact makers with relation to each other.

9. An electrical apparatus comprising a plurality of induction coils whose secondaries have at one end a point electrode, and at the other end a plane electrode, cooperating electrodes therefor, a condenser and interrupter in the circuit of the primaries of said coils, said interrupter comprising a mercury cup

having a series of movable contact makers movable in oil above said mercury, said condenser having a plurality of independent parts, and switching mechanism for throwing said parts independently into the circuit of said primaries.

Dated the 18th day of June 1901.

WM. BROOKES & SON,
55 & 56 Chancery Lane London
Agents for the Applicant

Redhill: Printed for His Majesty's Stationery Office, by Malcomson & Co., Ltd.—1901.

Fig. 1.

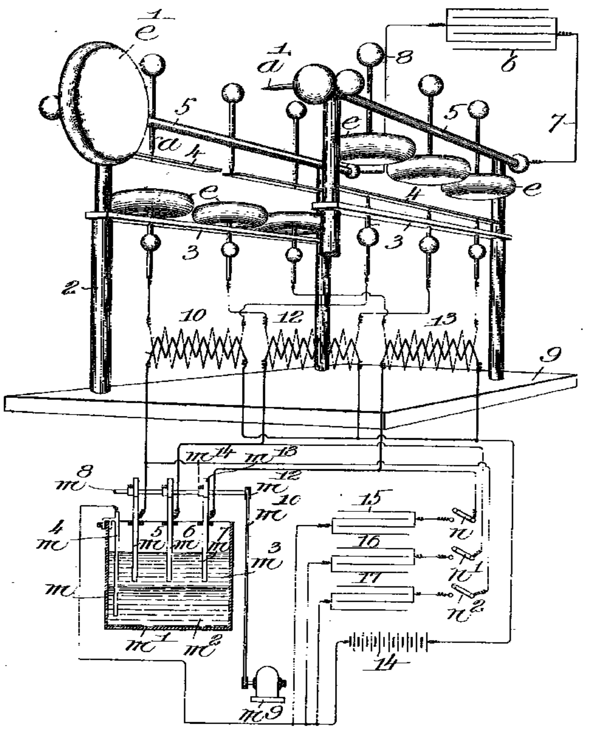
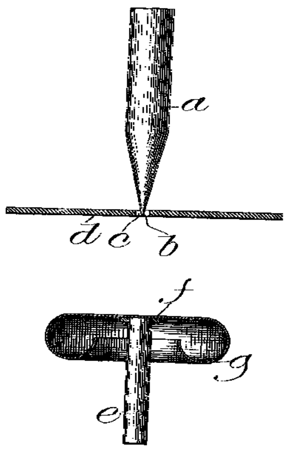
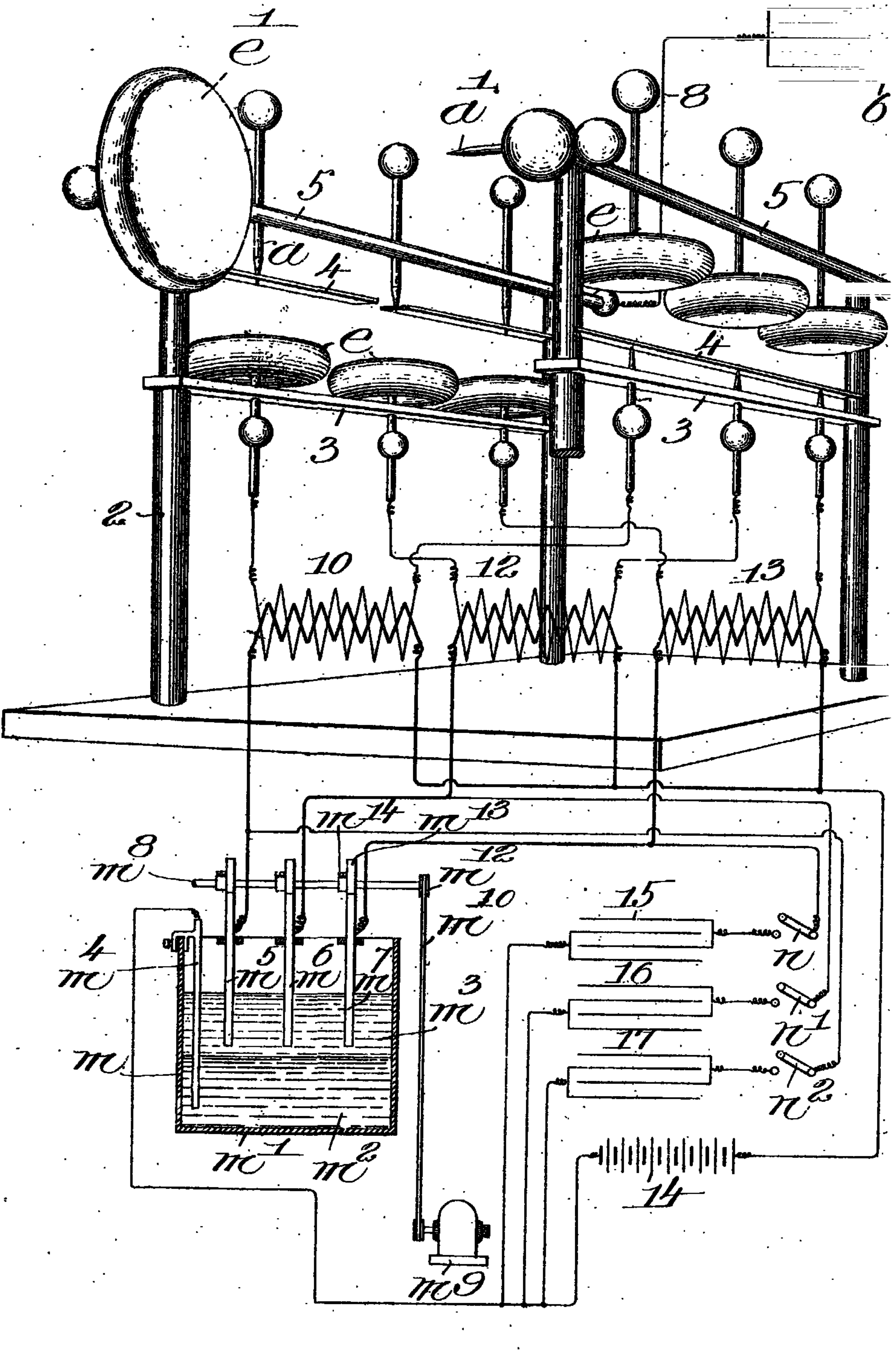


Fig. 2.



[This Drawing is a reproduction of the Original on a reduced scale]

Fig. 1.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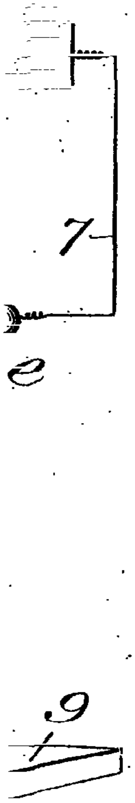
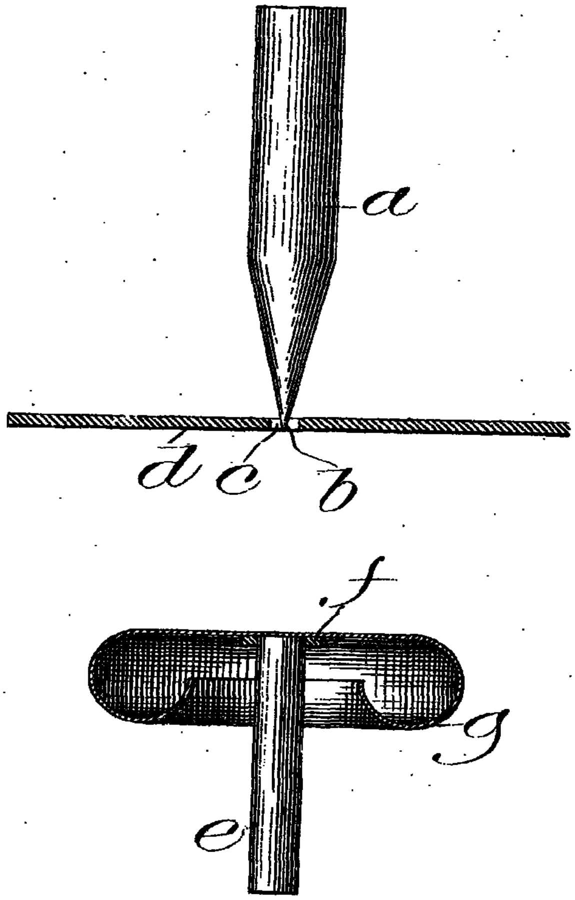


Fig. 4.



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A.D. 1901. JUNE 18. No. 12,408.
KINRAIDE'S COMPLETE SPECIFICATION.

(3 SHEETS)
SHEET 3.

Fig. 3.

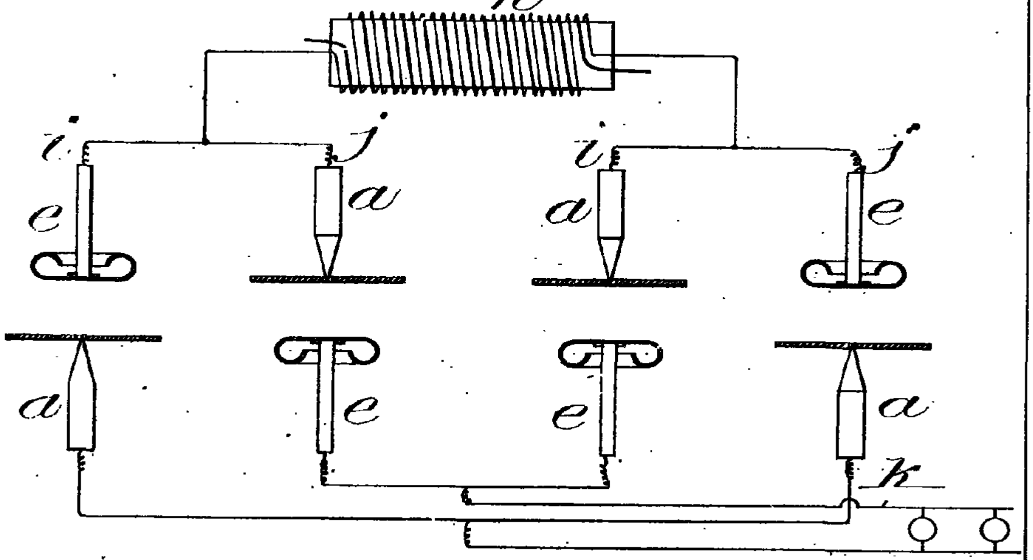
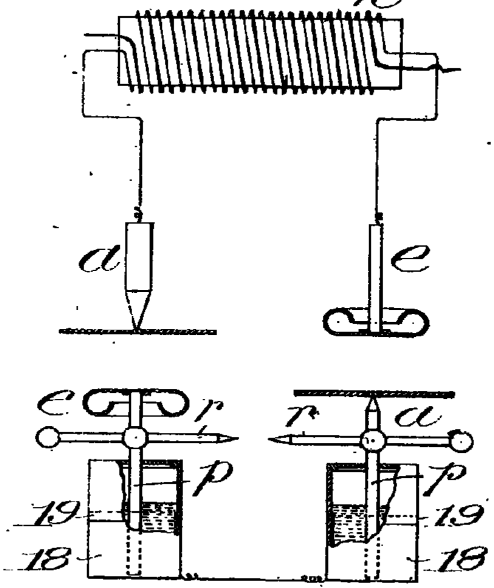


Fig. 4.



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Malby & Sons, Photo-Litho.

No. 615,652. Patented Dec. 6, 1898.

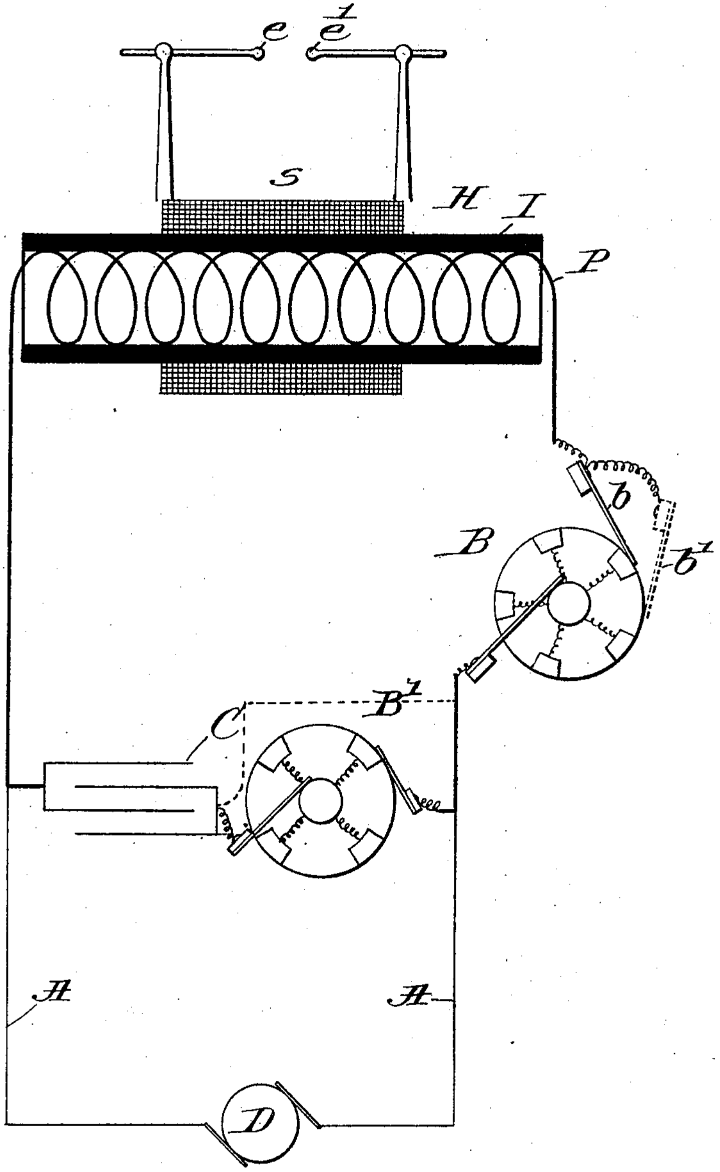
T. B. KINRAIDE.

HIGH FREQUENCY APPARATUS.

(Application filed May 13, 1897.)

(No Model.) 2 Sheets—Sheet I.

Fig. 1.



Witnesses:
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Thomas J. Drummond.

Inventor
Thomas B. Kinraide.
by Crosby & Gregory
Attys.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

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HIGH FREQUENCY APPARATUS.

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Fig. 2.

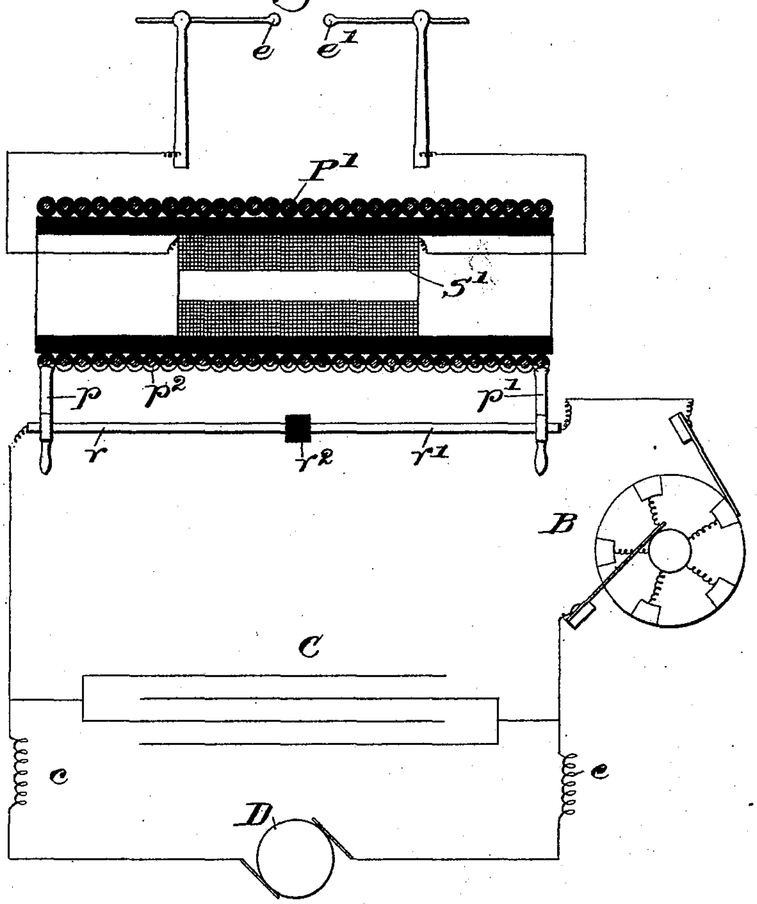
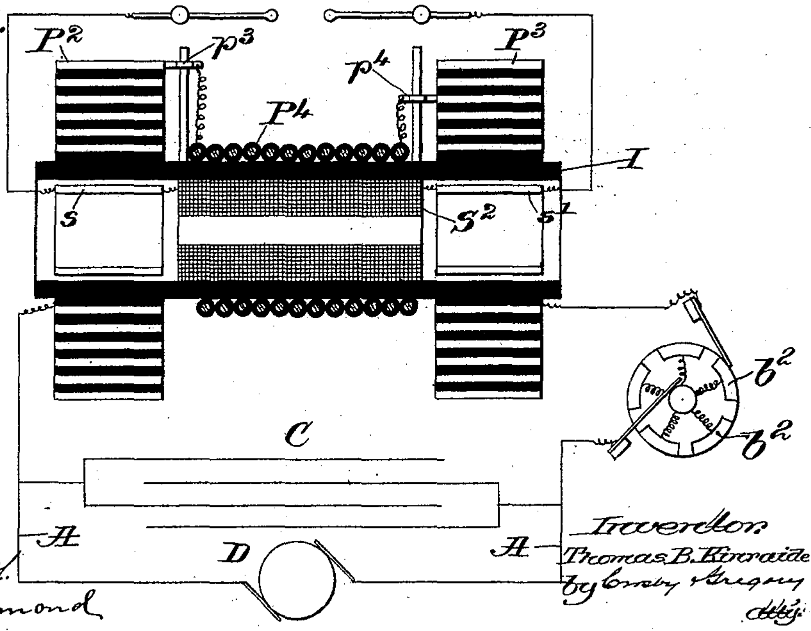


Fig. 3.



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by Crosby & Gregory
Attys.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

UNITED STATES PATENT OFFICE.

THOMAS B. KINRAIDE, OF BOSTON, MASSACHUSETTS.

HIGH-FREQUENCY APPARATUS.

SPECIFICATION forming part of Letters Patent No. 615,652, dated December 6, 1898.

Application filed May 13, 1897. Serial No. 636,293. (No model.)

To all whom it may concern:

Be it known that I, THOMAS B. KINRAIDE, of Boston, county of Suffolk, State of Massachusetts, have invented an Improvement in High-Frequency Apparatus, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

My invention relates to oscillators or high-frequency coils, having for its object the provision of compact apparatus of enormous rapidity and comparatively light weight and bulk especially adapted for work with X-rays.

The details of my apparatus will be more fully apprehended in the course of the following description, taken in connection with the accompanying drawings, illustrative thereof, and the invention will be more fully defined in the appended claims, forming a part of this specification.

In the drawings, Figure 1 shows diagrammatically one embodiment of a simple form of apparatus for carrying out my invention. Figs. 2 and 3 are similar views showing further features of the invention.

A A designate a circuit from a suitable source of electricity, herein shown as a dynamo D, this circuit being any usual commercial circuit or branch from a usual street-main or any other source of energy and leads directly, without any intervening apparatus, to a condenser C of small capacity.

The condenser is connected at either end (the right-hand connection being indicated by dotted lines, Fig. 1) to a coarse primary P, preferably having a single winding of a high-frequency coil H, a break B being interposed in the circuit, this break being shown as a commutator, although any other high-speed interrupter may be employed.

From the above description it will be understood that the dynamo is in direct circuit with the condenser, giving the latter a continuous primary charge, which is constantly piled up in the condenser; but the relatively coarse wires of the coil-circuit, the circuit being completed with great rapidity by the high-speed break, tend constantly to discharge the condenser, and this is accomplished and without any excessive raising of the potential thereby, so that the potential of the coil depends almost altogether upon the fluctuations of the condenser for its intensity.

The fluctuations in the oscillator or coil are exceedingly high, for the reason that the break is run at a very high speed and the secondary is tuned thereto, being of relatively few turns, as already stated, the result being that there is a very powerful sparking from the electrodes *e e'*, and yet the potential of the coil is not so high as in the oscillators at present employed, and therefore no oil insulation is required. This is a great desideratum in this apparatus, for the reason that the oil insulation has proved a very serious obstacle in practice.

In order to increase the efficiency of the apparatus still more, I prefer to construct the break or otherwise provide it with means whereby the intervals between the interruptions thereof may be proportioned to the time-constant of the circuit, and for this purpose I have indicated in dotted lines in Fig. 1 an adjustable brush *b'*, movable relatively to what I may term the "main" brush *b*, (shown in full lines,) these brushes being adjusted so that the two brushes shall both rest together on an insulation before the contact is again completed, the periods of contact between said interruptions being readily proportioned, as stated, by this means, so as to correspond to the time-constant of the circuit, or instead of the adjustable means shown in Fig. 1 and just described I may build the commutator, if that kind of interrupter be used, so that it shall be definitely proportioned originally as desired, this construction being indicated in Fig. 3, where the contact-segments b^2 are shown as having considerable peripheral area, so as to increase the period of contact of the brush to correspond to the time period of the circuit. This feature of my invention produces greatly-improved results in the oscillatory discharge of the coil.

Another improvement resides in providing an additional break B' at that end of the condenser which is adjacent the other break B, but not so as to cut off the circuit A from the latter break. I have indicated this break in Fig. 1. In this construction the breaks will be so constructed that certain of their interruptions will be substantially in unison and certain other of their interruptions will be out of unison—that is to say, if the breaks are both rotated on and by the same shaft or otherwise caused to rotate in synchronism.

The break B may have, for instance, thirty contact-segments and the break B' may have twenty contact-segments, so that as a result there will be in one revolution ten interruptions in unison and ten times when the two breaks will be half an interval apart and ten times when they will be a whole interval apart. Any other arrangement for producing this effect may be substituted. One break may have fifteen segments and the other twenty, &c.

The effect of the above-outlined construction is that the coil is given great frequency, and when the complete construction, as indicated, Fig. 1, is employed extraordinary results may be produced by causing the proportioning and arranging of the parts to be such that a spark-gap shall be maintained in the break B with an approximately continuous discharge, the break B operating in its revolutions to increase and decrease this spark-gap and the break B' interrupting the same by intermittingly connecting the condenser into the circuit thereof, so that the operation of the oscillator is brought down from the usual singing sound to a sharp decisive snap and the sparking thereof is changed from the usual bluish sparking to a series of white sparks. Indeed, for certain laboratory purposes a copper disk may be substituted for the break B, which being rapidly rotated will cause by reason of the slight unevenness of its surface and of the frictional contact of the brush therewith a pulsation or interruptive tendency in its circuit, producing to some extent a similar effect to that of the break B.

The primary P may be either inside or outside the secondary S, being insulated therefrom at I, and the coil may have a core, although I prefer to use it without a core.

In Fig. 2 I have shown the primary P' outside of the secondary S' and have shown means for adjusting the coil so as to perfectly balance the fluctuations thereof and produce the precise harmonic effect desired for the purposes of any particular use thereof—as, for instance, the study of striæ, &c.—this means consisting of two brushes p p', sliding back and forth by any suitable means, being shown as mounted on conductor-rods r r', insulated from each other at r^2, the insulation of the primary being grooved to form a contact-path p^2, along which the brushes may move in contact with the successive turns of the coil.

From the above description it will be evident that the sparking between the electrodes e e' may be varied, so as to get any kind of discharge desired, it being possible to move the brushes p p' together toward each other, so as to decrease the area of the primary evenly relatively to each end of the secondary, or to move one brush independently of the other, and thereby increase or decrease the relative area of the primary at one or the other end of the secondary, it being worthy of observation also that the portion of the primary which is cut out, or that is left remote from the secondary beyond the brush, is not cut out entirely, so as to be of no effect; but it has an appreciable effect in influencing the action of the coil, the latter being, however, more readily seen in connection with the apparatus shown in Fig. 3, to which reference will now be made.

I have shown a primary in Fig. 3 external to the secondary S^2 and made up of two separated portions P^2 P^3 adjacent the respective ends of the oscillator, each of these portions being made up of a flat helix of flat conductor, such as a copper ribbon, properly insulating from itself, as indicated, brushes p^3 p^4 being preferably provided movable up and down to contact with the successive layers of each helix, as shown, for the same purpose as already described in connection with the movable brushes of Fig. 2, the primary having an intermediate portion P^4 to give direction to the fluctuation. The secondary has preferably end pieces s s', which may be of copper or other conductor, being preferably ribbons of tin-foil secured to the inner surface of the insulation I, these extended areas of the secondary being in the direct field of influence of the portions P^2 P^3 of the primary. The operation and advantage of this construction is that it adds capacity to the high-frequency coils, so that a bright spark and heavy discharge takes place instead of the more disruptive discharge heretofore. The end portions of large area of the secondary give a condenser action to the secondary, tending to store or accumulate potential and produce much heavier and more sudden discharges with greater drop than would take place if the secondary terminated in the fine wire itself merely.

While I have described above my new method of operating an oscillator or high-frequency coil, I may remark that particularly in connection with the form of apparatus shown in Figs. 2 and 3 one or more choke-coils c (see Fig. 2) may be used in order to raise the potential.

The apparatus already described is of peculiar advantage for use in the observation of vacuum-tube discharges and the study of striæ, it being necessary in such matters to be able instantly and delicately to change the conditions of observation, the operator judging thereof by the appearance of the phenomena. For instance, if the striæ are confused and indistinct it is necessary to bring the coil into tune or at least into different tune from its condition, whatever the latter may be, and it is not always feasible and it may be, in fact, impossible to get the desired results by changing the speed of the break or the charging of the condenser or the capacity of the latter, &c., so that these observations are rendered extremely difficult and unscientific.

By the adjustable feature of my invention shown in Figs. 2 and 3 the coil may be instantly and accurately adjusted, so as to bring out the striæ distinct and clear. Again, still taking the study of striæ as an illustration, it frequently happens that the latter will constantly rush toward one end of the tube or will separate at the opposite ends thereof and will waver, so that they may not be readily studied or so that they may not be photographed, for instance. My invention enables the operator at once to throw the coil into such perfect balance that he may cause the striæ to remain perfectly stationary as desired simply by moving the brush *p* or *p'* outwardly at the end of the coil which proves to be the weaker, thereby bringing the influence of a higher potential to bear upon that end of the coil or by oppositely moving the other brush to lower the potential at the stronger end of the coil.

While I have herein shown a preferred embodiment of my invention I wish it understood that I am not restricted thereto, but that various changes in details and rearrangements of the combinations of parts may be resorted to within the spirit and scope of my invention as defined by the claims.

Having fully described my invention, what I claim, and desire to secure by Letters Patent, is—

1. In an induction device provided with a primary having a plurality of turns, means to shift the circuit connection from one turn to another transversely of said turns, at either or both ends of the coil at will, substantially as described.

2. The combination with a relatively immovable primary and a secondary of an induction device, of means to vary the position of the field of said primary relatively to the secondary by increasing said field at one end of the secondary and decreasing it at the other end, or vice versa, substantially as described.

3. The combination with a primary and a secondary of an induction device, of means to bring a greater or less number of turns of the primary into direct inductive action on the secondary independently at either end thereof, substantially as described.

4. The combination with a primary, of a secondary having opposite end portions of large area, substantially as described.

5. The combination with a primary, of a secondary, said secondary having opposite end portions of large area, and said primary also having relatively large area opposite thereto, substantially as described.

6. In an induction device, a primary having end portions of low resistance and extended area, substantially as described.

7. In an induction device, a primary having end portions of low resistance and extended area, said portions consisting of ribbon-like flat coils, substantially as described.

8. In an electrical apparatus, a source of energy, a primary, and a break in series circuit, and a condenser and second break in parallel across said source of energy, said second break being interposed at that end of the condenser adjacent said other break, said two breaks being constructed to give certain interruptions substantially in unison, and certain other interruptions out of unison, substantially as described.

9. In an electrical apparatus, a source of energy, a primary, and a break in series circuit, and a condenser and second break in parallel across said source of energy, said second break being interposed at that end of the condenser adjacent said other break, said two breaks being constructed to give certain interruptions substantially in unison, and certain other interruptions out of unison, and said first-mentioned break having the intervals between its interruptions proportioned to the time-constant of the circuit, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

THOMAS B. KINRAIDE.

Witnesses:
GEO. H. MAXWELL,
GEO. W. GREGORY.

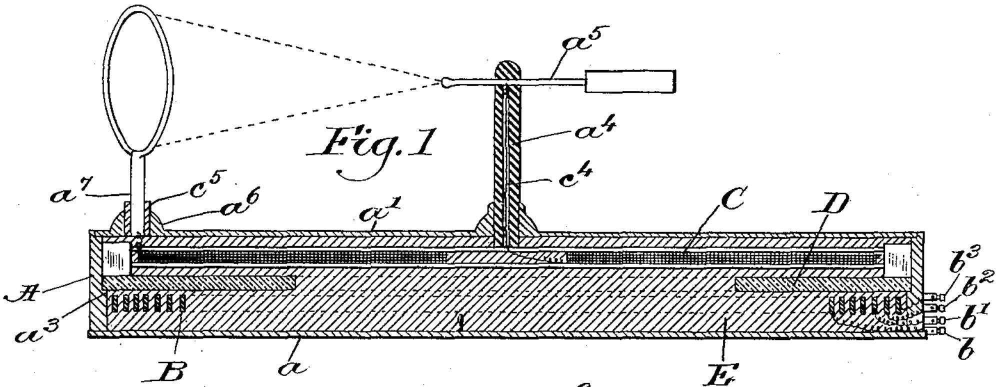
No. 615,653. Patented Dec. 6, 1898.

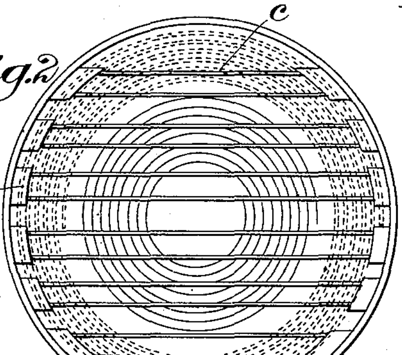
T. B. KINRAIDE.

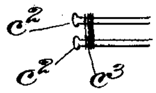
HIGH FREQUENCY INDUCTION APPARATUS.

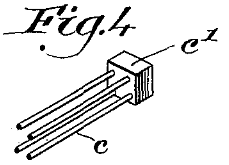
(Application filed Mar. 4, 1898.)

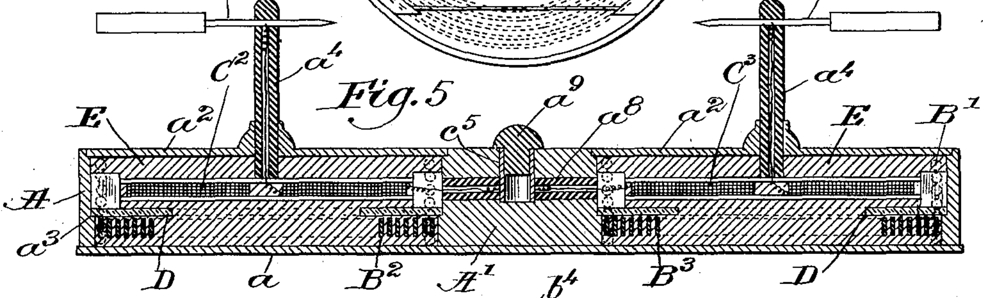
(No Model.)

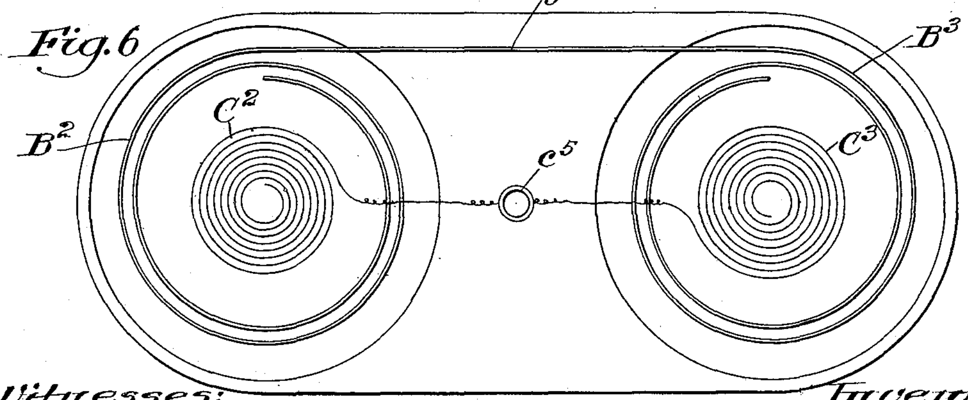












Witnesses:

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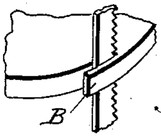
Walter E. Lombard.



Inventor.

Thomas B. Kinraide

by Crosby Gregory, Attys.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

UNITED STATES PATENT OFFICE.

THOMAS B. KINRAIDE, OF BOSTON, MASSACHUSETTS.

HIGH-FREQUENCY INDUCTION APPARATUS.

SPECIFICATION forming part of Letters Patent No. 615,653, dated December 6, 1898.

Application filed March 4, 1898. Serial No. 672,531. (No model.)

To all whom it may concern:

Be it known that I, THOMAS B. KINRAIDE, of Boston, county of Suffolk, State of Massachusetts, have invented an Improvement in High-Frequency Induction Apparatus, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

My invention is an improvement in induction-coils, and has for its principal object the provision of an apparatus capable of unlimited high frequency without danger of self-destruction or breaking down.

Induction-coils as ordinarily constructed are wound in disk form, the disks being placed side by side, usually in a columnar or tubular form over a central core, so that of course the coils are shortest, and hence offer least resistance, at the centers of the disks or next the core, and the highest potential is at the outside—*i. e.*, at the circumference of the disk—where the coils are the longest. I have departed entirely from this principle and have produced a flat coil in which the highest voltage is at the shortest turns and the lowest voltage is at the longest turns, or, in other words, the voltage increases inversely as the resistance.

In its simplest form and preferred embodiment my invention comprises a coarse primary of few turns and a fine secondary of many turns, preferably coaxially arranged, and the primary being confined to the low voltage or circumferential portion of the secondary.

The details of construction and the more complete embodiment of my invention and the more striking phenomena thereof will be set forth in the course of the following description, reference being had to the accompanying drawings, and the invention will be more particularly defined in the appended claims.

In the drawings, in which I have shown preferred embodiments of my invention, Figure 1 is a central vertical section of a simple coil or apparatus, illustrating one form of my invention. Fig. 2 is a top plan view thereof, on a reduced scale and partly diagrammatic, in order to give a clear understanding thereof. Figs. 3 and 4 are perspective details of insulators or separators employed. Fig. 5 is a view similar to Fig. 1, showing a complete embodiment of my invention. Fig. 6 is a top plan view thereof, partly diagrammatic. Fig. 7 is a fragmentary view showing one way of making the coarse primary.

In a box A of any suitable shape and size desired, being herein shown in Figs. 1 and 2 as circular and in Figs. 5 and 6 as oblong with rounded ends, I mount a primary B and a secondary C, a partition D, preferably of glass, being interposed between the primary and secondary, if desired, although it may be omitted. The box A has preferably a removable bottom *a* and top *a'*, Fig. 5, these parts being preferably constructed of vulcanite or other insulating material.

When a partition D is employed, a ledge a^3 may be molded, stamped, or turned, if desired, on the inner wall of the box, on which the partition may be seated, and for neatness of construction the top also will preferably rest on a similar ledge. The top and bottom may be screwed or otherwise secured to the edges of the walls or rim of the box, although I wish it understood that the details of the inclosing box may be infinitely varied within my invention.

I wind the secondary C, of fine wire and such area as is desired, in the form of a thin flat disk and secure it by suitable means in one of the sides of the box, herein shown as the upper side, the securing means being herein shown as comprising a plurality of glass rods *c*, arranged in pairs oppositely placed above and below the secondary and together constituting a holding-grid. It is obvious that this grid may be made in any form, the parallel bars being preferred merely for convenience. Having properly positioned the secondary between its holding-rods *c* or such other holding devices as may be used, I preferably connect the terminals of the secondary with a current sufficient to raise the secondary to a considerable heat and then pour into the box a melted insulating compound E, preferably of rosin and beeswax, sufficient to fill the box and entirely cover the secondary, preferably also covering the holding-rods *c*, as is indicated in the figures, maintaining the heat for a sufficient time to insure that the melted rosin and wax shall have permeated into every interstice of the secondary and its neighboring parts. The primary is put in position in the same manner, excepting that no holding-grid is necessary therefor, inasmuch as the inherent rigidity of the coarse wires prevents any buckling or warping thereof under the action of the heated insulating compound. The result is that when the insulating compound has hardened the primary and the thin flat disk of the secondary are insulated absolutely.

In view of the fact that my secondary is made of such fine wire and in the form of a thin disk it is necessary that it should be positively held by a grid-like holder while the wax is being poured, as otherwise it would work out of shape.

The rods c may be held at their ends by glass blocks c', as shown in Fig. 4, or a more convenient construction is that shown in Fig. 3, where it will be seen that the rods are severally provided with heads c^2 and are tied together simply by wrapping a piece of silk thread c^3 around the ends thereof. This latter construction is extremely convenient. These glass rods, it may be remarked, are also advantageous for holding thin or fragile conductors in various other relations than that herein shown.

It will be observed that the partition D is cut away at its middle portion, so that it will be understood that both sides, or, in other words, the entire apparatus, is poured at once with the insulating compound. The compound which I have mentioned is normally solid, and therefore there is no tendency in the apparatus to leak; but, on the contrary, it is substantially one piece or solid, without any danger of loosening or getting injured. Moreover, if from any cause whatever any heating effects have been produced at any point in the apparatus, it is evident that the fusible insulating compound would be softened or melted sufficiently to cause it automatically to flow around the heated portions and maintain perfect insulation.

I prefer to employ a primary made as illustrated in full lines in the figures, where it will be seen that it consists of a flat helix of coarse wire or metal, although it may be in other forms—for instance, as indicated in dotted lines at B' in Fig. 5. This helix B is conveniently made by sawing a piece of sheet metal to produce the form shown, (see Fig. 7,) the air-gap formed by the saw-cuts being sufficient in practice to insulate the primary, especially when embedded in the insulating compound, as explained.

I have shown both primary and secondary as circular, although it will be understood that they may be square, oval, or any other shape desired—oval, for instance, being preferable where it is desired to get a long spark-gap in an instrument of the form shown in Fig. 1.

In the above description I have purposely omitted all technical details of construction in order to present my invention in its broad features and in its simplicity, although it will be understood that proper binding-posts and connections will be provided, as indicated at b^2 b^3, Fig. 1, and that the other usual features of regulation will be used in connection therewith, including a break, condenser, &c. The inner terminal of the secondary is shown at c^4 as extending in a central post a^4 to a usual adjustable electrode a^5, and the opposite terminal of the secondary is shown in Fig. 1 as terminating at a thimble or ferrule c^5 in a socket a^6, which may contain any suitable electrode, a ring-discharger a^7 being shown in place therein.

Referring to Figs. 5 and 6, it will be seen that I have provided two primaries B^2 B^3, connected together at b^4, and two secondaries C^2 C^3, electrically connected by a contact ring or ferrule c^5 similar to that already described. The two primaries and secondaries are separated by an insulating-block A', which constitutes a portion of the box, and they are embedded in insulating compound precisely the same as described in the simpler form of the apparatus shown in Fig. 1, it being understood that the connecting-wires of the primary and secondary are carried through insulating-tubes, as is indicated at a^8, Fig. 5. The inner terminal of each of the secondaries C^2 C^3 connects with a central post a^4, containing an electrode a^5, as already described, and the thimble or ferrule c^5 (shown in Fig. 5 as stopped by a plug a^9) is adapted to receive a discharge-ring a^7 or any other form of electrode, although usually it will be stopped by the plug, as shown. The primary is restricted to the circumferential portion of the secondary—that is to say, it is located in the vicinity of the outer or larger turns of the secondary in the form of an annulus having a large central aperture. Besides this, I make the primary relatively short and of large cross-sectional area, the latter feature giving the primary large condenser or static capacity. Also there is an entire absence of any core or anything of that nature to produce sluggishness. The result is that I am enabled to obtain exceedingly high frequency without destructive heating.

The primary being entirely or mainly located at one side of or adjacent the circumferential portion of the secondary and there being no core of magnetic material, but only electrical inductive action, there results a piling up or condensing of the lines of force at the center of the secondary in an obvious vertical form, so that the potential or voltage of the inner portion of the coil is high and of the outer portion low. The intensity of the electrical field is enormously increased at the center of the coils and nearly all the lines of force of the entire coil are concentrated upon this central portion thereof, and the construction is such that this condition is maintained—that is to say, there is an enormous propulsive discharge from the electrode at the center of the coil and there is scarcely any discharge from the outer electrode thereof at c^5. This will be understood by referring to Fig. 1, where I have indicated by dotted lines the discharge effects. The discharge takes place or may take place like radiant flames collected by a ring, as shown in Fig. 1, or by removing the ring or turning the electrode a^5 at some other angle this radiant discharge simply shoots out into space.

One great advantage besides that already pointed out of the high frequency and enormous discharge is that there is no fear of melting down the coil. Heretofore in induction-coils it has been necessary to exercise extreme care in regulating the discharge-terminals so as to prevent too great resistance between them, as otherwise the apparatus would at once short-circuit itself and quickly be ruined, whereas in my present invention all this is done away with.

While I have herein described a preferred embodiment of my invention, I wish it understood that very many changes and rearrangements may be resorted to without departing from the spirit and scope of the invention and that I am not limited otherwise to details than as expressed in the appended claims.

Having described my invention, what I claim, and desire to secure by Letters Patent, is—

1. An induction device, comprising a secondary in the form of a flat coil, and a primary in the form of a flat coil, superimposed flatwise and coaxially one on the other, said primary being in the form of an annulus having a large central aperture relatively to the said coaxial secondary, as and for the purpose set forth.

2. An induction apparatus comprising a winding producing an exciting-field, and an electric conductor excited thereby, said conductor having a plurality of turns of varying lengths, said field-winding being located adjacent the longer of said turns, and the shortest of said turns having the highest voltage, substantially as described.

3. An induction apparatus comprising an electric conductor whose resistance per turn diminishes as its voltage increases, and an exciting-field winding adjacent and confined to the low-voltage portion of said conductor, substantially as described.

4. In an induction apparatus, a plurality of turns of electric conductor, said conductor being constructed and wound to present decrease of resistance in the turns toward one end with an increase of voltage toward the same end when under the influence of current, and means to maintain said high voltage at said end of minimum resistance per turn, substantially as described.

5. An induction device having a primary of sheet metal, the turns of said primary being insulated from each other by a saw-cut, substantially as described.

6. An induction device comprising a shallow box having a closed bottom and an intermediate partition, said partition extending to the walls of the box parallel to the bottom, a flat coil of a single thickness of wire being contained between the partition and the bottom of the box and confined to that portion thereof adjacent the walls of the box, and a flat coil constituting a secondary being contained in the box on the opposite side of said partition and extending approximately to the center of the box, the box being filled with, and said primary and secondary being embedded in, a fusible insulating substance normally solid, substantially as described.

7. An induction device comprising a shallow box having a closed bottom and an intermediate partition, said partition extending to the walls of the box parallel to the bottom, a flat coil of a single thickness of wire being contained between the partition and bottom of the box and confined to that portion thereof adjacent the walls of the box, and a flat coil constituting a secondary being contained in the box on the opposite side of said partition and extending approximately to the center of the box, the box being filled with, and said primary and secondary being embedded in, a fusible insulating substance normally solid, said secondary being retained from warping by means of an insulating-grid comprising bars extending across it both above and below, substantially as described.

8. An induction apparatus comprising a plurality of primaries connected together in series at one of their terminals, combined with a secondary for each primary, said primaries and secondaries being constructed and arranged to maintain high voltage at the center of each secondary, and low voltage at the circumferential terminals thereof, the inner terminal of one of said secondaries being positive and the inner terminal of the adjacent secondary being negative, substantially as described.

9. An induction apparatus comprising a plurality of primaries connected together in series at one of their terminals, combined with a separate secondary for each primary, said secondaries having regions of high voltage at their centers, and regions of low voltage at their circumferential terminals when the apparatus is in action, substantially as described.

10. An induction apparatus comprising a plurality of primaries connected together, and a secondary for each primary, said secondaries being respectively located substantially coaxially relatively to their primaries, and each being wholly or mainly within the primary, the latter being adjacent the circumferential portion of the secondary only, whereby a large propulsive discharge may be maintained at the central terminal of the secondary with an inappreciable discharge at the circumferential terminal thereof, substantially as described.

11. An induction apparatus comprising a

plurality of coarse, short, flat-coiled primaries connected together, and a corresponding plurality of long, fine secondaries wound in the form of flat coils, each primary being wound with a large central aperture, and having its coils restricted to the area adjacent the longer of the turns of its secondary, substantially as described.

12. An induction apparatus comprising a shallow box having a plurality of compartments and removable tops therefor, each compartment containing a coil constituting a primary, and a second coil constituting a secondary, said coils being coaxial with each other and the secondary extending within the primary, said coils being embedded in a fusible insulating substance normally solid and filling said several compartments, said box having insulated passages connecting said boxes, and said several primaries having one of their terminals communicating through said passages, and a discharge post or device for the central terminal of each secondary, substantially as described.

13. An induction device comprising a shallow box having a closed bottom, a flat coil of a single thickness of wire adjacent said bottom and confined adjacent the walls of the box, and a flat coil constituting a secondary winding contained in the box adjacent the other winding and extending approximately to the center of the box, said secondary winding being retained from warping by means of a plurality of glass bars arranged transversely thereof on opposite sides of the winding, the box being filled with and said primary and secondary being embedded in a fusible insulating substance normally solid, substantially as described.

14. An insulating-grid adapted to bind together and insulate a disk or other winding, said grid being composed of glass bars arranged opposite to each other on opposite sides of the winding and projecting therebeyond at their ends, said ends having heads adapted to be bound together by a filament, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

THOMAS B. KINRAIDE.

Witnesses:
GEO. H. MAXWELL,
ALEXANDER C. PROUDFIT.

No. 770,432. PATENTED SEPT. 20, 1904.

T. B. KINRAIDE.

HIGH POTENTIAL INDUCTION COIL.

APPLICATION FILED MAY 25, 1904.

NO MODEL.

Fig. 1.

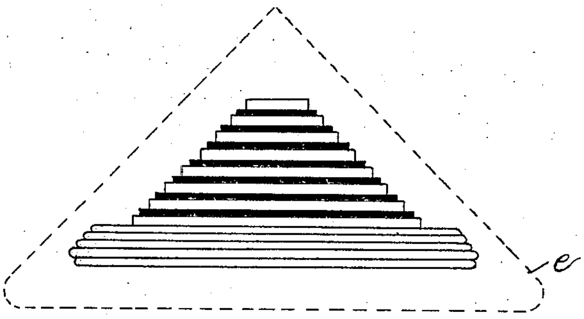


Fig 2.

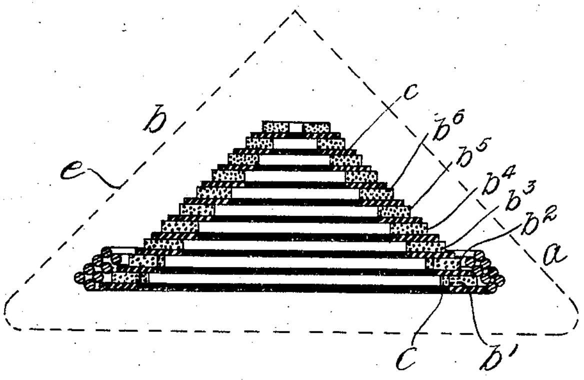
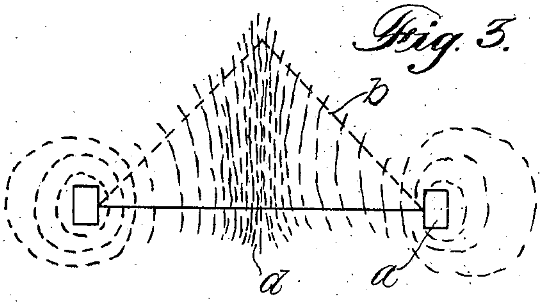


Fig. 3.



Witnesses:—
John E. Porter.
Alexander Lincoln

Inventor:—
Thomas B. Kinraide.
by Geo. H. Maxwell
Attorney.

No. 770,432. Patented September 20, 1904.

UNITED STATES PATENT OFFICE.

THOMAS B. KINRAIDE, OF BOSTON, MASSACHUSETTS.

HIGH-POTENTIAL INDUCTION-COIL.

SPECIFICATION forming part of Letters Patent No. 770,432, dated September 20, 1904.

Application filed May 25, 1904. Serial No. 209,684. (No model.)

To all whom it may concern:

Be it known that I, THOMAS B. KINRAIDE, a citizen of the United States, residing in Boston, in the county of Suffolk, State of Massachusetts, have invented an Improvement in High-Potential Induction-Coils, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

My present invention is an improvement in that kind of apparatus which I have patented heretofore and whose advantages and purposes are set forth in my Patent No. 615,653, dated December 6, 1898, the present invention having for its object the provision of means for greatly increasing the efficiency and capacity of the coil.

One of the main objects of my special kind of coil as outlined in the aforesaid patent is to obtain a unidirectional discharge or high voltage at the center, and for this purpose the turns are made successively shorter as they recede from the surrounding primary, or, in other words, the coil is helical for providing the constantly-decreasing resistance per turn, and in my present invention I avail myself of the same principle of construction, having, however, provided means for rendering it feasible to employ coarse wire of many turns, whereby the coil has low resistance, and hence higher frequency and higher voltage. I accomplish this object by winding the coil in the form of a cone, so that the windings overlap each other and gradually approach the center. When the windings are in a flat coil, it is obvious that the extent of wire is limited to that number of turns whose aggregate diameters of wire equal the diameter of the coil, because each turn must necessarily be within the adjacent turn, whereas by building the coil in the form of a cone it is possible to have the successive layers or turns overlap the preceding layers or turns and yet be successively shorter sufficiently to insure a unidirectional flow of the current or a tendency of the current to flow in one direction, due to the constantly-decreasing resistance of the successive portions of the coil.

My invention will be further explained as to its construction, operation, and advantages in connection with the accompanying drawings, in which I have shown one embodiment of my invention, and the latter will be more particularly defined in the appended claims.

In the drawings, Figure 1 is a view in side elevation of the preferred embodiment of my invention. Fig. 2 is a vertical cross-sectional view thereof. Fig. 3 illustrates diagrammatically certain advantages thereof.

It will be understood that in the drawings I have not undertaken to show the complete mechanical embodiment or to illustrate the construction of the coil itself.

A coarse primary *a* of one or more turns is provided at the base of the coil, and from said base the secondary *b* is wound, being preferably wound in successive ring-like layers, the largest being indicated at b' at the base of the coil and thence extending diagonally upward, as indicated at b^2 b^3 b^4 b^5 b^6, &c., these successive layers being supported by insulator-rings *c*. This construction permits each successive turn or layer of secondary wire to overlap the preceding layer, and yet each successive layer is shorter, and therefore has less resistance, than the preceding layer. For example, b^2 overlaps b' and is overlapped by the layer b^3, so that although each layer may thereby have the same number of turns yet these turns can be composed of coarser wire than would be the case if all the layers were in the same flat plane with the layer b'. Also this construction brings the entire mass of secondary within the saturated field *d* of force, as indicated diagrammatically in Fig. 3. The decreasing resistance of the turns maintains the highest potential at the center, and the overlapping of the turns, and hence employment of coarse wire, still further decreases the resistance of the successive turns, so that the frequency and voltage are extremely high. The resistance of any secondary when operated from a condenser determines the frequency of the coil, and by my invention, which permits the employment of coarse wire, the resistance is reduced to a minimum. The angle or pitch of the cone will vary according to the conditions and purposes of use, and ordinarily the coil will be inclosed in a suitable jacket and incased in wax, as indicated by the dotted line *e*.

My invention is capable of a wide variety of embodiments and an extended field of usefulness, being specially adapted for use wherever exceedingly high frequency is desired without liability of breaking down under severe usage.

While the employment of a long coarse-wire secondary wound as explained is of great value and an important feature of my invention, I do not restrict myself thereto, as the conical arrangement is of advantage for many purposes with fine wire, nor do I limit the invention except as otherwise required in the claims to the particular shape shown.

Having fully described my invention, what I claim as new, and desire to secure by Letters Patent of the United States, is—

1. An induction-coil whose secondary is composed of a plurality of overlapping sections successively shorter as they recede from the primary.

2. An induction-coil having its secondary composed of a plurality of successively shorter sections of greater aggregate width than the diameter of the coil, thereby decreasing the resistance, for affording very high potential.

3. An induction-coil having a conical secondary.

4. An induction-coil comprising a primary and secondary, the latter having its successive sections, toward the center, of decreasing resistance, and having a plurality of the longer sections directly adjacent the primary.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

THOMAS B. KINRAIDE.

Witnesses:
Geo. H. Maxwell,
R. S. Ford.

No. 623,316. Patented Apr. 18, 1899.

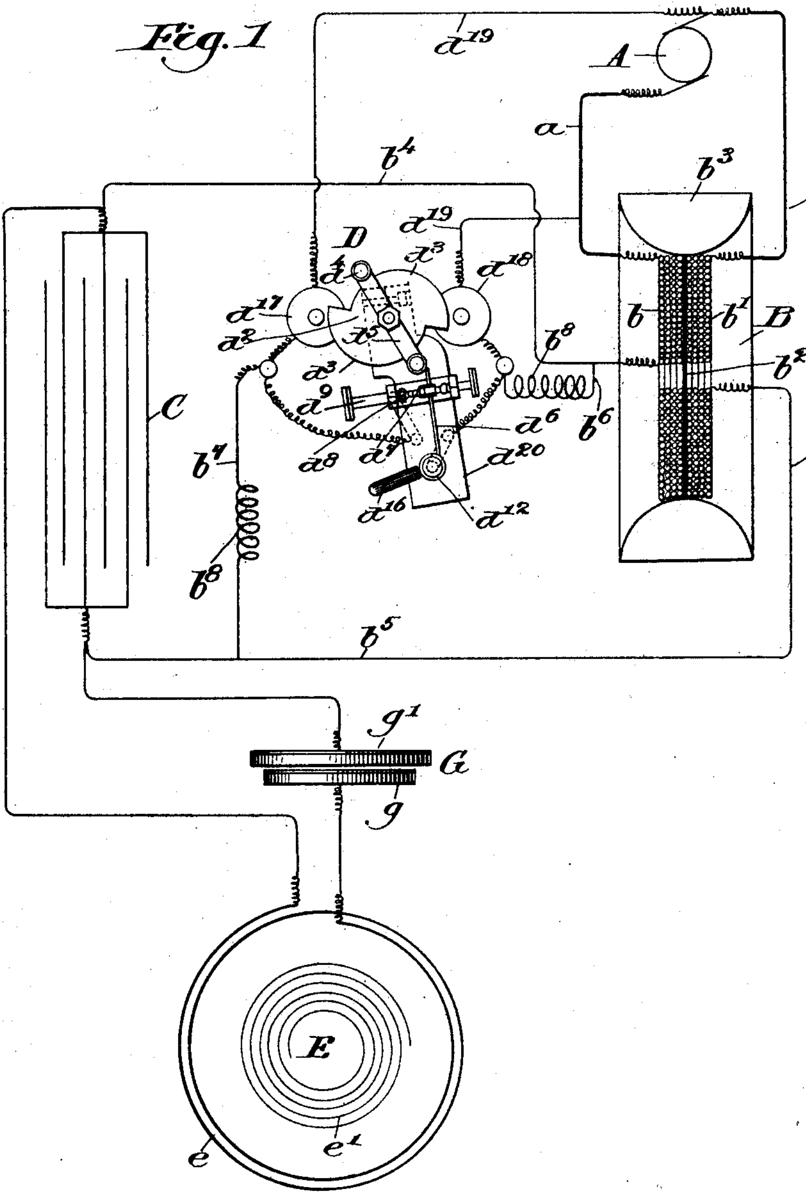
T. B. KINRAIDE.

INDUCTION APPARATUS.

(Application filed May 5, 1898.)

(No Model.) 3 Sheets—Sheet I.

Fig. 1



Witnesses:

A. C. Harmon

Fred S. Greenleaf

Inventor:

Thomas B. Kinraide

by Crosby & Gregory

attys.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 623,316. **Patented Apr. 18, 1899.**

T. B. KINRAIDE.

INDUCTION APPARATUS.

(Application filed May 5, 1898.)

(No Model.) 3 Sheets—Sheet 2.

Fig. 2.

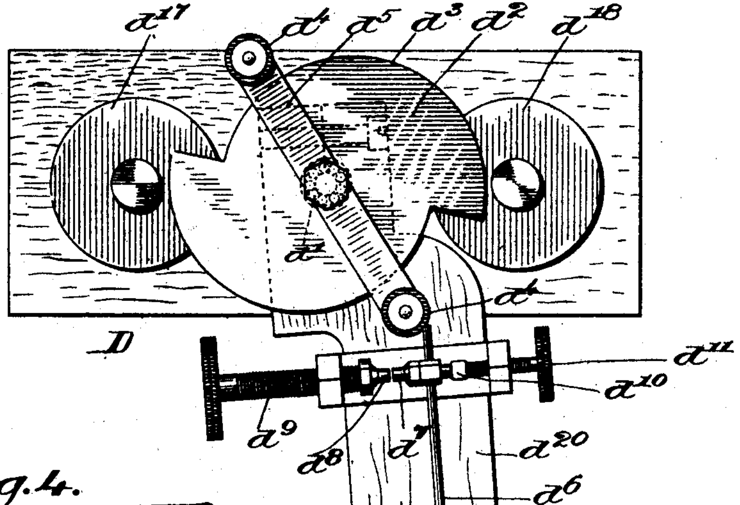


Fig. 4.

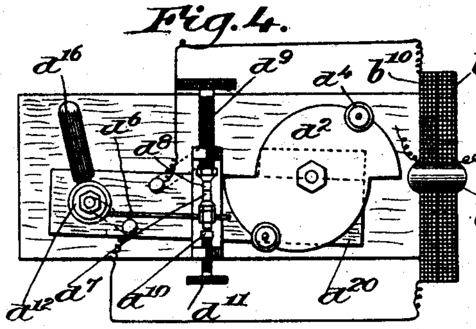
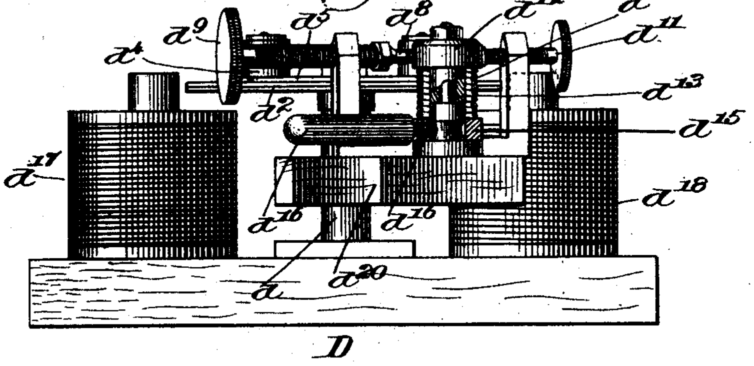


Fig. 3.



Witnesses:

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INDUCTION APPARATUS.

(Application filed May 5, 1898.)

(No Model.) 3 Sheets—Sheet 3.

Fig. 5.

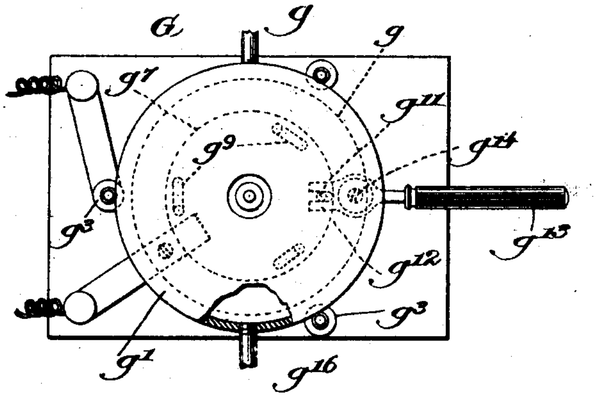
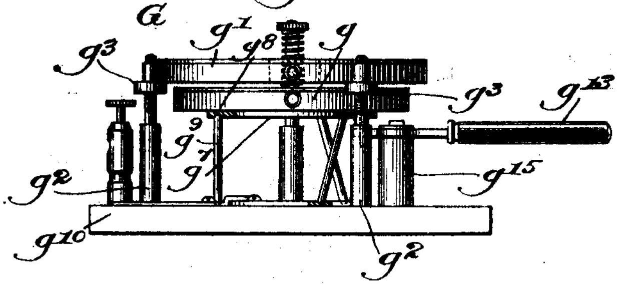


Fig. 6.



Witnesses:

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by Crosby & Gregory

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UNITED STATES PATENT OFFICE.

THOMAS B. KINRAIDE, OF BOSTON, MASSACHUSETTS.

INDUCTION APPARATUS.

SPECIFICATION forming part of Letters Patent No. 623,316, dated April 18, 1899.

Application filed May 5, 1898. Serial No. 679,799. (No model.)

To all whom it may concern:

Be it known that I, THOMAS B. KINRAIDE, of Boston, county of Suffolk, State of Massachusetts, have invented an Improvement in Induction Apparatus, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

My invention is an improved induction apparatus whereby discharges are made possible of greater efficiency, as will more fully appear in the course of the following description.

I will describe the details of my invention with reference to the accompanying drawings, which illustrate a preferred form of the apparatus.

In the drawings, Figure 1 is a view, partly diagrammatic and partly in section and plan, illustrating the arrangement of the system according to my invention. Fig. 2 is a top plan view of the break. Fig. 3 is a front elevation thereof, parts being broken away to show the detailed construction. Fig. 4 is a view similar to Fig. 2, showing a modified form thereof. Fig. 5 is a top plan view of my improved spark-gap. Fig. 6 shows the spark-gap in elevation.

Heretofore there has always been a considerable amount of waste energy in systems for developing high potential, and also there has been an ever-present danger of breaking down and destroying the apparatus by its own output, and accordingly it has been my present aim to provide a system in which all the increase of potential which may be developed shall be delivered for use for the translating devices and in which the apparatus is self-containing and practically indestructible.

Let A designate a dynamo, battery, or any other suitable source of electrical energy. From the dynamo the current passes by conductors a a' to an inductance device B, each conductor a a' having its own coil b b', said coils being preferably insulated from each other, as indicated at b^2, and surrounded by a laminated core b^3. Each coil b is wound transversely back and forth until the opposite terminals b^4 b^5 reach the center and are thence carried to the opposite ends of a condenser C, a break D being interposed and connected to the main conductors b^4 b^5 at b^6 b^7 and the discharge from the condenser being received by a translating device (herein shown as a special induction-coil E) by means of an automatic spark-gap G.

Each one of the details of apparatus above enumerated as constituting my system is of special construction and peculiar effect in the system, whereby it becomes possible to discharge currents of considerable strength with great velocity through the primary of the coil E, the discharge across the spark-gap being of very great amperage and exceedingly short and sharp oscillations.

Referring now to the inductance device B, I will explain that the object of this device is to raise the potential of the current and cause all this increase of potential to pass to the condenser, preventing any of it from discharging through the dynamo.

By my device the total potential is delivered only from the forward end of the wire or the one toward the condenser, and also there is only one end of the coil which has high potential. This is because the lines of magnetic force occasioned by the flow of the electric current, which during said flow are radiated from the core or field b^3, fall from the center across all the turns of wire into the periphery as the circuit is interrupted, and hence maintain a region of constant magnetic intensity at the periphery, effectually checking all rise of potential at that end, but leaving the opposite or outgoing end free from the presence of the lines of magnetic force as soon as the break occurs, and therefore without impedance. As soon as the current is broken the lines of force fall back toward the iron core and leave the central portion of the coil free from the restraining influence of these lines of force, said lines cutting across the successive turns of wire, the coil being left free to permit the induced current of increased potential to flow toward the center of the coils or toward that point which has no magnetic field whatever to choke back the current, thereby permitting the latter to rush out unconfined and unrestrained toward its natural outlet; but as the lines of the magnetic field are constantly maintained with maximum impedance at the periphery of the coil and remain surrounding the peripheral turns until the very last moment of the fall due to the break in the circuit their presence there prohibits any possibility of manifestation of the rise of the potential in the current at that end of the coil, so that all the increase of potential in the whole coil is obliged to find an outlet from the center, and the ease of outflow from this outlet increases as the lines of force fall away from the center, thereby removing their restraining and impeding influence therefrom. This will be clear by bearing in mind the action which takes place in what is commonly called a "choke-coil"—*i. e.*, a winding about an iron core, said winding being in a spiral from one end of the iron to the other. In such a coil it is obvious that when a current passes the lines of force rise equally along the extent of the entire coil and that when the current is broken the lines of force fall directly in, perpendicular to the core, thereby cutting each turn of the spiral equally and at the same time, thereby producing high pressure at both ends of the choke-coil, the potential being necessarily the same at both ends of the wire, because both ends are affected by the same conditions of falling lines of force.

In my coil the lines of force do not fall equally on all the turns; but there is a minimum intensity at the center and a maximum intensity at the periphery, the latter being the point of entrance of the current, so that the current due to self-induction is always free to be drawn off, as it were, into the condenser at one end as fast as it is developed and is prevented from departing at the opposite end, or, stated in other words, while the current from the dynamo is always free to flow into the coil for having its potential raised the said potential must all seek its outlet at the opposite end of the coil, so that all the current of the coil flows therefrom into the condenser, whereas in a choke-coil the induced current may be said to ooze out at both ends, so that the benefit is not received of all that is developed.

By my coil all the lines of force are collected for cutting from the center across the entire coil, whereas in the usual choke-coil the lines of force that fall at the center cut only the central turns, so that in my coil I develop all the potential that is possible to be developed.

I regard it as a new principle to withdraw the lines of magnetic force away from that portion of the coil from which the current is being drawn and maintain a magnetic field at that portion of the coil which receives the current.

Other features of construction to be noted in the coil shown in Fig. 1 are that the high-potential end of the coil is that portion of least resistance, because the central turns are of course shorter than the peripheral turns. The resistance in the coil diminishes as the potential increases; also, it will be observed that I have given the magnetic core substantially the form of a semicircle in cross-section, my reason for this form being that thereby the lines of magnetic force are given their best radiation or are distributed to the best effect on the coil, it being understood that these lines leave the iron perpendicular to its surface and are gradually bent around toward the coil.

Referring now to the break D, (best shown in Figs. 2 and 3,) I journal in a central post or bearing d the spindle d' of an iron plate or armature d^2, having two or more eccentric edges d^3, as clearly shown in Fig. 2, or other provision of regions of increasing magnetic attraction. Mounted on or otherwise connected to rotate therewith are one or more small antifriction-rolls d^4, two being herein shown mounted at the opposite ends of a bar d^5, clamped adjustably on the plate d^2. These rolls or circuit-interrupters are preferably of indurated fiber. Mounted to extend into the path of the rolls d^4 is an arm (shown as a wire d^6) carrying a hammer d^7 to contact with an anvil d^8 on a post d^9 and limited in its movement by a fiber stop d^{10} on the end of an adjusting-screw d^{11}. The wire d^6 is carried by a hub d^{12}, loose on a pin d^{13} and held under tension by a spring-coil d^{14}, Fig. 3, fastened at one end to said hub and at its other end to a nut d^{15}, carrying an adjusting or set screw d^{16}, so that by loosening the set-screw and swinging its handle one way or the other the resistance of the arm d^6 may be varied. Opposite the surfaces d^3 I place solenoids or electromagnets d^{17} d^{18}, operated by taps d^{19} from the main circuit entering the solenoids at their inner terminals, so that as the magnets d^{17} d^{18} are energized they attract the plate d^2, and by the increasing pull exerted thereon on account of the eccentric surfaces d^3 they cause the plate to rotate with a speed only checked by the striking of the interrupters d^4 against the end of the arm d^6, said rolls being placed relatively to the highest points of the surfaces d^3, so that they cut off the current just before said highest points get opposite the propelling-magnets, thereby permitting the momentum of the plate or armature d^2 to carry said highest points beyond the magnets sufficiently to prevent the latter exerting any retarding influence on the rotation of the break. Preferably I mount the anvil and hammer on a swinging ledge or carrier d^{20}, journaled on the post d, so that I am enabled to regulate the speed of the break simply by swinging the carrier d^{20} one way or the other. The same effect may be obtained by shifting the roll or rolls d^4 on the plate d^2, provided they are carried, as preferred, on a bar d^5, so that they can be shifted; but this adjustment cannot of course take place while the apparatus is in operation, and therefore for instantaneous regulation of the apparatus and of the system I provide the swinging carrier d^{20}. A movement of the carrier from right to left in the diagram causes the current to be broken before the armature has reached its point of greatest attraction, and as it is moved farther toward the left the pull on the armature exerted by the magnets is diminished more and more and the speed of rotation of the armature is correspondingly reduced, thereby reducing the number of breaks and at the same time lengthening the time which the circuit of the inductance-coil is closed. This is of great importance, because thereby it results that the degree of magnetic saturation of the core or field b^3 may be increased up to its highest limit.

I place the arm or wire d^6 slightly tangential to the armature, as will be seen viewing Fig. 2, in order that the rolls d^4 may strike the extreme end thereof with least friction, striking outward instead of square against the end.

The mains b^4 b^5, Fig. 1, are connected, as stated, to the break by the conductors b^6 b^7, and in order that the condenser may not discharge back through the break I interpose in these conductors a resistance, herein shown as consisting of a few small turns b^8. The discharge from the condenser will seek the path of least resistance, and therefore I interpose just sufficient resistance at b^8 to prevent said discharge acting through the break, but not enough to render the condenser inoperative. One object of this special break is to make it possible to get all the efficiency out of the inductance apparatus B that there is. This would be impossibe with any usual break, for the reason that if a usual break were used, so as to give an equivalent period in which the circuit was closed, the brush would remain upon the surface of the break, tending through the heat or friction engendered to arc upon it, so that the condenser could not receive the full charge from the inductance-coil, but a portion would be lost upon the break-surface. My break, however, gives an absolutely instantaneous break, this break, moreover, being of extremely short duration, so that in practice I am enabled to leave the circuit closed during thirty-five thirty-sixths of the period of rotation of the break-armature, thereby leaving the inductance-coil B all of this period in which to raise its potential. It will be understood that as the point of highest saturation of the core is approached the discharge into the condenser is much greater in volume than if the magnetic flux were not complete.

In my break there is not only no chance for it to arc, as there is no surface for it to arc over, but the break itself is so exceedingly quick that there is not even a spark at the time of break, but there is merely occasionally a residual spark upon the closing of the break. Thus I am enabled to avoid entirely the considerable loss of energy heretofore consumed by the break, and I am enabled by the use of this break, in connection with the special inductance-coil B, to charge the condenser with an amperage which has not been possible in any system heretofore. Also by reason of the spark-gap G, which I will now describe, I am enabled to maintain the condenser action at the maximum charge and without any danger of breaking it down.

I provide electrodes in the form of opposite parallel disks g g', the air-gap between whose plane surfaces constitutes the spark-gap, the extended area of these electrodes preventing the tendency of the condenser to discharge until it has reached its maximum charge, and also causing the discharge to be exceedingly sudden when it does take place and the disks not being liable to become unduly heated. The spark-gap G constitutes virtually a self-recuperative or indestructible condenser, as it were, the parallel and preferably plane metallic surfaces g g' being the discharge-surfaces which discharge through or across the intervening air-dielectric. The air-gap is broken through when the voltage has exerted a sufficient strain upon the air to rupture it. The larger the disks are the farther apart they will spark. At each discharge of the condenser a small portion of these plates is oxidized, the successive discharges producing very thin oxidation here and there until the entire surfaces of the two disks are completely oxidized. Referring to Figs. 5 and 6 for the details of this spark-gap, it will be seen that I provide a plurality of posts g^2, threaded at their upper ends and carrying shouldered nuts g^3, on the shoulders of which is placed the top disk g', being held accurately on said shoulders by a spring g^4 under a tension-nut g^5, said nut and spring being mounted on the reduced end of a central post g^6, over which the plates g g' are placed. The opposite plate g rests on a support or table g^7, provided on its under side with a plurality of recesses or sockets g^3, herein shown as three in number, which receive props or struts g^9, projecting upwardly from the base g^{10} of the instrument. These props g^9 are of precisely equal length, so that they support the plate g in absolute parallelism to its opposite plate g'. The support g^7 has depending from its lower side a stud g^{11}, which is engaged by the bifurcated end g^{12} of a lever g^{13}, pivoted at g^{14} to a post g^{15} on the base. By this provision the most delicate adjustment is possible simply by swinging the lever g^{13} one way or the other, so as to incline the struts g^9 more or less, and thereby increase or decrease the distance between the plates g g', the nuts g^3 being depended upon for the coarser adjustments of the plates.

I have shown the plates g g' as hollow and provided with water-circulation pipes g^{16} in order that they may be absolutely prevented from all heating under extraordinary conditions.

The induction-coil E comprises a primary e of large cross-sectional area, capable of receiving a considerable amperage, the secondary e' being wound on the principle explained in connection with the coils b b', so that its inner terminal alone has the high-potential discharge, the other terminal having comparatively no discharge. I do not herein claim this induction-coil, inasmuch as it forms the subject of another application and is therein claimed; nor will I herein further describe the details thereof, merely showing this particular coil for the reason that this is the only coil known to me which can be used for obtaining the best results from my system; nor do I herein claim the special break device, nor the special spark-gap, inasmuch as these form the subjects-matter of other applications, Serial Nos. 691,757 and 691,758, filed September 24, 1898, and are therein claimed, and it will accordingly be understood that while these particular instruments are preferably employed in my system I do not intend to restrict the latter thereto, nor otherwise than as expressed in the following claims. The conditions that are obtained in this system make it possible to discharge currents of enormous strength with great velocity through the primary, the velocity obtained making it possible to raise the potential in the secondary enormously, and the said potential being confined to one terminal only a resulting discharge is obtained representing the total of the potential that otherwise would be manifest at both terminals of an ordinary coil.

The spark-gap G is adjusted to the point of discharge of the condenser which it is desired the latter should maintain, and accordingly said condenser is automatically discharged as often as it rises to said point of maximum charge, and it can never be overcharged, for the reason that the spark-gap remains unvarying.

The use of the plates g g' makes possible the sudden discharge of the condenser after it has reached the certain predetermined point mentioned, and said discharge is of great volume or large amperage and of a very sudden and abrupt nature, as the current will not break across the spark-gap until it cannot help doing so, and when it does do so the discharge takes place with a minimum heating effect, not interfering with the efficiency, with very rapid and with very short and sharp oscillations, incapable of being obtained between a ball or point discharge-gap and productive of very great results in the secondary.

The plates g g' of the gap G are adjusted to the potential at which it is desired the condenser C shall discharge, and then the break D is regulated to give the volume or amperage of current which it is desired shall charge the condenser, the latter being automatically discharged as frequently as its charge reaches the predetermined limit to which the spark-gap has been adjusted. For example, supposing that the break D is adjusted so as to require the inductance device B to operate at its saturated point, as before explained. Then the number of discharges of the condenser across the spark-gap during each fluctuation in the coil B will be many more times than if the break D were operating more rapidly, and hence the rapidity of the discharge from the induction-coil E is increased in its efficiency, giving more volume of discharge.

It must be understood that the potential that is developed in the induction-coil E is not as great when the plates g g' are brought near together as it is when they are far apart, because in the latter case the condenser charge becomes greater necessarily before it is discharged. By increasing the length of the spark-gap, the speed of the break remaining the same, I get an increase of potential in the oscillator or induction-coil E, and also I may obtain the same effect without varying the length of spark-gap by decreasing the speed of the break.

The maximum potential obtainable from the induction-coil is when the break is adjusted to rotate at a speed sufficient to permit the saturation of the core b^3 and the spark-gap at G is lengthened so that the condenser is allowed to charge to its full capacity.

The sudden opening of the break-gap wide enough so that no discharge may take place thereat, but all the charge seeks a much better channel of discharge in the condenser, taking place as it does in an exceedingly small interval of the period of rotation of the break, gives the inductance-coil B volume of discharge such that it may charge the condenser a considerable number of times before another break takes place; or, to put this in another way, my apparatus enables me to produce a charge from the device B of such enormous volume that the spark-gap G will be called upon to automatically discharge the condenser a number of times during the interval of one falling of the lines of force in the inductance device B.

I regard myself as the first to provide an induction system capable of automatically regulating itself so as to maintain a given discharge, and I also believe myself to be the first to provide an apparatus capable of maintaining said condenser-discharge at a given amperage.

The frequency by my system is practically unlimited, inasmuch as a plurality of inductance devices B may be connected independently to the break D and condenser C, merely being arranged to operate out of step with each other, and there will be no danger to the condenser, for the reason that the spark-gap G will take care of all the charge which may be delivered to the condenser.

My system enables me to use a small condenser and yet with enormous efficiency therefrom.

While I have herein described preferred embodiments of my invention, I do not restrict myself thereto. For example, the electromagnets d^{17} d^{18} need not be used; but instead thereof the inductance device B may be oppositely wound, as indicated in Fig. 4, so that the core b^9 will be properly located for running the armature d^2 of the break. In this case I make the ends of the core b^9 hemispherical, thereby obtaining the same advantage before explained in connection with the similarly-shaped surfaces of the core b^3, and the coils b^{10} b^{11} will be wound back and forth transversely in the same manner as the coils b b', the difference being that in this case the inner terminal becomes the low-potential end of the coils for connection to the dynamo and the outer terminals are the high-potential ends of the coils for connection to the condenser, this form of apparatus, however, not being so efficient as the form previously described, for the reason that the outer or longer turns present an increased resistance to the higher potential, whereas the best effects can be obtained, as before explained, by presenting a decreasing resistance to an increasing potential.

Having described my invention, what I claim, and desire to secure by Letters Patent, is—

1. In a system of the kind described, an electric circuit, means including a condenser to impress thereon a current of high frequency, combined with means for automatically discharging the condenser at any predetermined degree of charge, and means for varying the amperage charge of the condenser, substantially as described.

2. In a system of the kind described, a source of electrical energy, and a condenser, combined with a device for raising the potential of the current, means for discharging said raised potential solely in one direction from said device, and means for controlling the potential of said device, substantially as described.

3. In a system of the kind described, a source of electrical energy, a break, condenser, and a translating device to receive the discharge from the condenser, combined with means for preventing the discharge of the condenser back through the break, substantially as described.

4. In a system of the kind described, the combination with a source of electrical energy, a break, and condenser, of an inductance device between said source of energy and the break, said device having a magnetic core, and coils in the influence of said core and wound to present high potential at one end and low potential at the other end, said coils having their low-potential terminals connected to the source of energy, and their high-potential terminals connected to the condenser, and interrupted by the break, substantially as described.

5. In a system of the kind described, the combination with a source of electrical energy, a break, and condenser, of an inductance device between said source of energy and the break, said device having a core producing a magnetic field, and coils in the influence of said field and wound to present high potential at one end and low potential at the other end, said coils having their low-potential terminals connected to the source of energy, and their high-potential terminals connected to the condenser, and interrupted by the break, and means to vary the degree of magnetic saturation of said field in the operation of the system, substantially as described.

6. In a system of the kind described, a source of electrical energy, a break, and a condenser, combined with means independent of the break for automatically regulating the frequency of discharge from said condenser, substantially as described.

7. In a system of the kind described, a source of electrical energy, an inductance device for raising the potential of the current therefrom, said device delivering said potential in one direction only and away from the source of energy, a break provided with means for maintaining long intervals of closed circuit, and sudden short intervals of break, a condenser, and an automatic discharge device for said condenser, substantially as described.

8. In a system of the kind described, a source of electrical energy, an inductance device for raising the potential of the current therefrom, said device delivering said potential in one direction only and away from the source of energy, a break provided with means for maintaining long intervals of closed circuit, and sudden short intervals of break, a condenser, means preventing back discharge from the condenser and sparking at the break, and an automatic discharge device for said condenser, substantially as described.

9. The combination in an electrical circuit, of an inductance-coil having a core producing a magnetic field and wound to present a high-potential region at one end and low-potential region at the other end, the terminal thereof connected with the source of current-supply being at said low-potential region, and the opposite terminal being at said high-potential region, said coil having the potential thereof decreasing in a constant ratio from the one to the other terminal, and mechanism for interrupting the said circuit, said mechanism comprising means for maintaining the circuit closed in periods sufficient to fully charge said magnetic field, substantially as described.

10. An inductance-coil comprising a core, and a winding of current-conductor centrally of said core, said winding being in two coils, each having one terminal adjacent said core and the other terminal removed from said core, with all the windings of the coil located between said two terminals, and said coil having its potential varying per turn progressively in a constant ratio throughout its length from one terminal to the other terminal, substantially as described.

11. In an inductance-coil, a peripheral core or magnetic body, and a winding of current-conductor within the field of said magnetic body, said conductor being wound to present

its successive layers of windings successively shorter from the periphery to the center of the coil throughout the entire length of the conductor, substantially as described.

12. In an inductance device, a magnetic core, and a coil adjacent thereto, said core presenting curved surfaces adjacent the coil curving therefrom in a direction away from the coil, whereby the lines of magnetic force leaving the core perpendicular to said surfaces are widely distributed about the coil, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

THOMAS B. KINRAIDE.

Witnesses:
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No. 770,431. PATENTED SEPT. 20, 1904.

T. B. KINRAIDE.

INTERRUPTER.

APPLICATION FILED APR. 6, 1904.

NO MODEL. 2 SHEETS—SHEET 1.

Fig. 1.

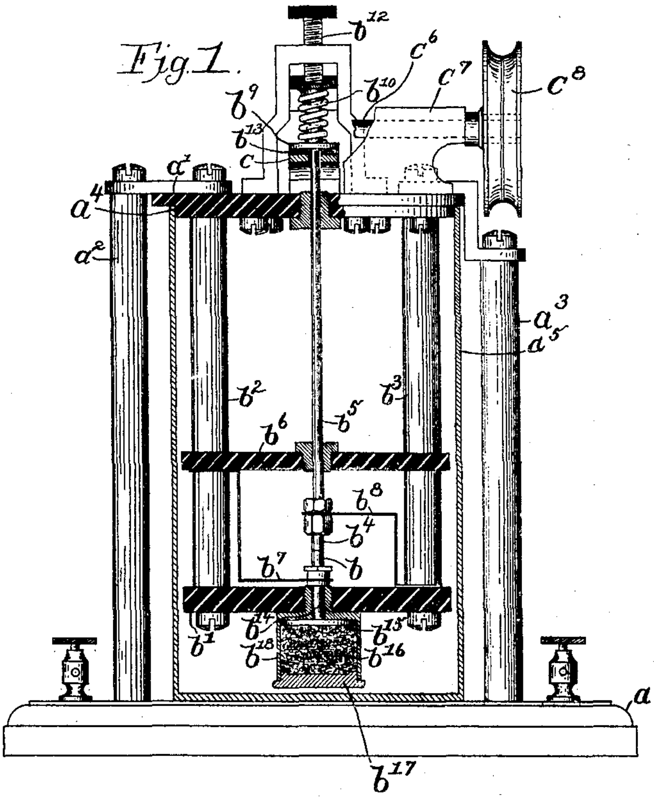
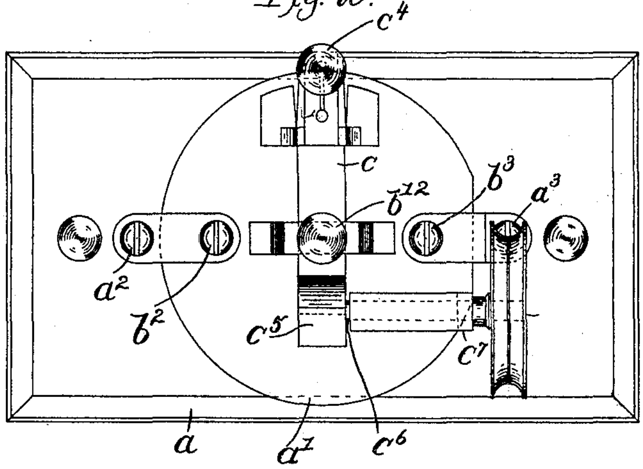


Fig. 2.



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No. 770,431. PATENTED SEPT. 20, 1904.

T. B. KINRAIDE.

INTERRUPTER.

APPLICATION FILED APR. 6, 1904.

NO MODEL. 2 SHEETS—SHEET 2.

Fig. 3.

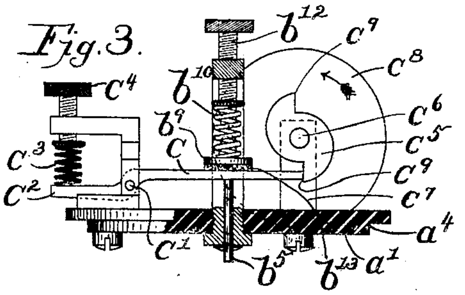


Fig. 4.

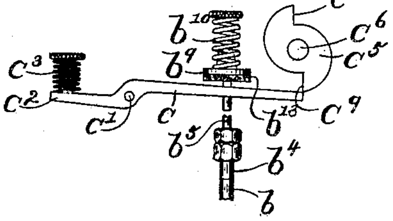


Fig. 5.

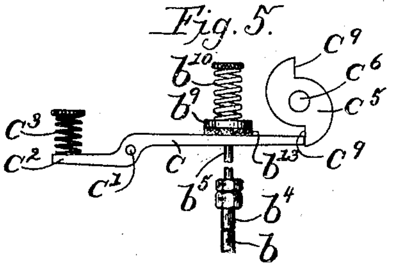
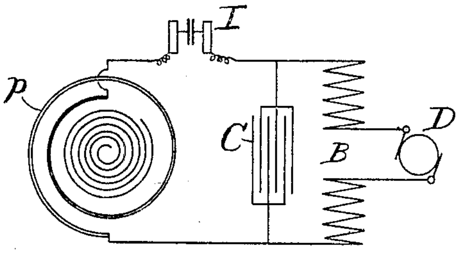


Fig. 6.



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No. 770,431. Patented September 20, 1904.

UNITED STATES PATENT OFFICE.

THOMAS B. KINRAIDE, OF JAMAICA PLAIN, MASSACHUSETTS.

INTERRUPTER.

SPECIFICATION forming part of Letters Patent No. 770,431, dated September 20, 1904.

Application filed April 6, 1904. Serial No. 201,941. (No model.)

To all whom it may concern:

Be it known that I, THOMAS B. KINRAIDE, a citizen of the United States, and a resident of Jamaica Plain, in the Commonwealth of Massachusetts, have invented an Improvement in Interrupters, of which the following description, in connection with the accompanying drawings, is a specification.

My invention is an improvement in interrupters, and has for its object the provision of means for obtaining a quick short break, the means for obtaining the same, as herein shown, being mechanical. In other words, the object of my invention is to cause a break for the least possible time and to keep the circuit closed the longest possible time, and to accomplish this result it is necessary as far as possible to do away with momentum, having no hammer as such, but providing a striking device operating against the tension of a spring suddenly released.

In my Patent No. 623,318, dated April 18, 1899, I have shown and described a "spark-gap" composed of plates one of whose functions is to receive a condenser discharge when properly adjusted, and one of the objects of the present invention is to obtain certain of the advantages of the aforesaid construction by means of an interrupter, and I obtain the same by having the separation of the electrodes so brief and sudden that the movable electrode returns just in time to take the condenser discharge and prevent the surging back of the impulse or wave from the condenser which would otherwise take place through the inductance-coil, but which by having the break short and quick (and the parts free of momentum) permits the gap to close in time to direct the condenser discharge through the primary of the induction-coil, and the break or gap can be so adjusted as to consume or receive all the condenser discharge as fast as conveyed to it, thereby preventing all surging back, and hence securing the greatest efficiency at the primary.

Various other advantages and further constructional details of my invention will be pointed out and the operation thereof will be fully set forth in the course of the following description, reference being had to the accompanying drawings, in which I have illustrated a preferred embodiment of my invention.

In the drawings, Figure 1 is a central vertical section of one form of my interrupter. Fig. 2 is a top plan thereof. Fig. 3 is a fragmentary view in vertical cross-section, taken at right angles to Fig. 1. Figs. 4 and 5 are fragmentary details similar to Fig. 3, showing, respectively, the interrupter in position about to give a break and in position just causing a break. Fig. 6 is a diagrammatic view showing the circuit connections for which my interrupter is particularly adapted.

The main principle of my interrupter is that the break is caused by a striker propelled by a suddenly-released spring or by equivalent means, which causes the same to give a hammer-like blow, without, however, employing a hammer. The old interrupter employs a swinging hammer or momentum device and is practically limited in its operation to the momentum due to its weight, and this very weight also renders its action necessarily sluggish, which is further increased by the action of the electromagnet, which tends to hold the hammer until deënergized. Having premised this much, my invention will be readily understood from the following brief description.

Mounted on a suitable base a is a top plate or support, herein shown as a cap a', retained by posts a^2 a^3 and shouldered at a^4 to engage the upper end of an oil well or cup a^5, in which the separating contacts or electrodes are mounted.

As herein shown, the fixed electrode b is mounted in a cross-bar b', carried by two opposite rods or conductors b^2 b^3, and the movable electrode b^4 is carried by a rod b^5, slidingly mounted in a cross-bar b^6 and in the top plate a', conductor-wires or copper ribbons b^7 b^8 being connected, respectively, with the electrodes b b^4 and to the rods b^2 b^3. The rod b^5 has a shoulder or head b^9 at its upper end and is normally held in contact with electrode b by a spring b^{10}, whose tension is regulated by a thumb-screw b^{12}. Beneath the head b^9 is a striker c, shown as a light plate-metal arm pivoted, as at c', and having its rear end c^2 engaged by a spring c^3, whose tension is regulated by a thumb-screw c^4. The striker c is freely movable toward and from the head b^9, a piece of felt or other cushioning material b^{13} being interposed for lessening the noise, and the end of the said striker projects forward into the path of an actuator, herein shown as a shouldered cam c^5, mounted on the end of a shaft c^6, journaled in a block c^7 and carrying at its opposite end a drive wheel or pulley c^8.

As the cam rotates in the direction of the arrow, Fig. 3, the parts first assume the position shown in Fig. 4, spring c^3 being strongly compressed and striker c moved back away from the head b^9 of the movable electrode or electrode-carrier, and thereupon further rotation of the cam permits the striker to escape from the shoulder c^9 thereof, and instantly spring c^3 causes said striker to deliver a sudden and severe blow against the head b^9, which instantly separates the electrodes; but as the force of the blow is spent the very moment it strikes the head b^9, there being no heavy swinging hammer or momentum device, the blow is given entirely by the suddenly-released spring, or, in other words, the mechanical actuator or cam that operates the striker does not deliver the blow, but the latter is brought about entirely separately from the cam by the suddenly-released spring. This will act to open a strongly spring closed pair of contacts, which could not be opened even by a heavy hammer, and yet it will do so with a quickness and to such a slight extent that the closing is almost instantaneous, and thereby accomplishes the short break and quick closing which is the principal object of the invention.

The chatter or noise of the contacts or electrodes b b^4 upon each other, due to the strong action of the spring b^{10}, is objectionable, and I have found that it can be almost entirely prevented by providing the supporting-rod b^{14} of the electrode b^7 with a head b^{15}, resting against a cushion, shown as consisting of a series of felt disks b^{16}, retained by a removable cap b^{17} in a casing b^{18}, supported on the under side of the plate b', so that as the blow of the movable electrode is delivered the noise is effectually prevented.

The operation of my invention will further be understood by reference to Fig. 6, where it will be seen that the interrupter I is contained in the circuit of a primary p of an induction-coil, the other end of the primary leading to an inductance-coil B and thence to a source of energy D, a condenser C being inserted across the circuit between the inductance-coils and the interrupter. With an old interrupter operating in the above system the action would necessarily be so sluggish as to obtain little efficiency, the discharge from the condenser surging back through the inductance-coils during the break or period of opening of the electrodes; but by reason of the extremely short and quick break made possible by my interrupter the discharge from the condenser is received by the movable electrode just as it is moving back into closed position, and this operation is repeated, so as to consume all the condenser discharge as fast as it is delivered.

In the preferred form of my apparatus, which I have described above, the cam c^5 releases the striker twice at each rotation, the force of the blow being determined by the adjustment of the striker-spring c^3, and the striker spends its force against the shoulder or head b^9, delivering the blow, however, against the felt buffer b^{13}, and instantly the spring b^{10} restores the contacts to closed position. In other words, the desired intense quickness of movement is due to the inertia of the contact and its spring and to the fact that when the thin light striker has delivered its quick-flying blow it instantly parts with its force, there being nothing to continue its impelling movement, as would be the case if it were weighted like a hammer, and therefore the result is that the instant the force of the striker is spent against the contact-head the high-tension spring of the latter closes the contacts again. The periodicity of movement thereof may be regulated by adjusting the tension of the spring so as to insure that the open interval corresponds to the time of the forward wave or impulse of the condenser.

As the electrode returns to closed position and strikes against the relatively fixed contact the noise is taken up or absorbed by the sound-deadening felt disks b^{16}, which are retained in the oil-tight casing b^{18}.

It will be understood that I have shown merely one of the many embodiments of which my invention is capable, the present embodiment being well adapted to continuous and hard usage; but I do not intend to limit myself to the constructional details herein set forth, excepting as otherwise required in the claims.

Having described my invention, what I claim as new, and desire to secure by Letters Patent of the United States, is—

1. An interrupter, comprising separable contacts, means tending to maintain them closed, a striker for momentarily separating them, impelling means for imparting the striking movement to said striker, and an independent actuator therefor.

2. An interrupter, comprising separable contacts, a striker for suddenly moving one of said contacts, and a mechanical actuator for operating said striker.

3. An interrupter, comprising separable contacts, yielding means for maintaining them closed, and spring-impelled means for momentarily separating said contacts.

4. An interrupter, comprising separable contacts, yielding means for maintaining them closed, a striker having its striking end thin and light for reducing momentum effects to a minimum, a spring adapted to be compressed

and released for causing said striker to separate said contacts by the force of its impact, and means for releasing said spring.

5. An interrupter, comprising separable contacts, a striker having a thin, light, striking end, means consisting of a released spring for imparting a sudden striking impulse to said striker for separating said contacts, and means for instantly counteracting the separating effect of said striker and closing the contacts.

6. An interrupter, comprising separable contacts, a striker, means consisting of a released spring for actuating said striker to separate said contacts, and an oppositely-acting spring for instantly closing the contacts thus separated.

7. An interrupter, comprising separable contacts, a striker for separating them, and a cam-actuator for operating said striker.

8. An interrupter, comprising separable contacts, carrying means for one of said contacts provided with a shoulder or head, a cushion on the inner side of said head and a spring-impelled striker for acting against said cushion to separate said contacts.

9. An interrupter, comprising separable contacts, carrying means for one of said contacts provided with a shoulder or head, a cushion on the inner side of said head and a spring-impelled striker for acting against said cushion to separate said contacts, and a cushion bearing against the outer end of the other of said contacts.

10. An interrupter, comprising separable contacts, a striker for moving one of them, a cushion-holder provided with sound-deadening yielding material, and means carried by the other of said contacts for bearing against said materials and thereby deadening the sound of the closing of said contacts.

11. An interrupter, comprising separable contacts, quick separating means therefor, quick closing means, and sound-deadening means for receiving the closing impact of said contacts.

12. An interrupter, comprising separable contacts, quick separating means therefor, quick closing means, and sound-deadening means for receiving the closing impact of said contacts, consisting of a series of felt layers for receiving the closing impact of said contacts.

13. An interrupter, comprising separable contacts, quick separating means therefor, quick closing means, and sound-deadening means for receiving the closing impact of said contacts, an oil-well inclosing said contacts, and an oil-tight casing inclosing said sound-deadening means.

14. The combination with an induction-coil and condenser of an interrupter, comprising separable contacts, separating means and closing means therefor for giving a long closed period and an exceedingly short open period, and adjusting means coöperating therewith to give said contacts a periodicity of movement to receive and transmit the full condenser discharges.

In witness thereof I have signed my name to this specification in the presence of two subscribing witnesses.

THOMAS B. KINRAIDE.

Witnesses:
R. S. Ford,
John E. Porter.

(No Model.)

T. B. KINRAIDE.

METHOD OF AND APPARATUS FOR CONVERTING X RAYS INTO LIGHT FOR PHOTOGRAPHIC PURPOSES.

No. 595,812. Patented Dec. 21, 1897.

Fig.1.

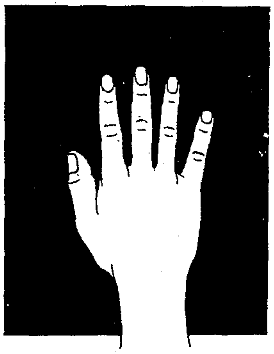


Fig.2.

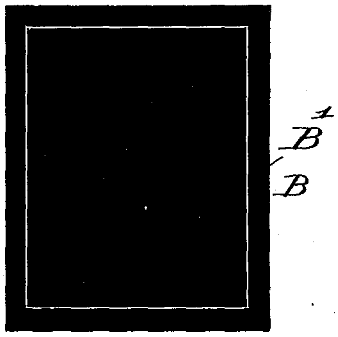


Fig.3.

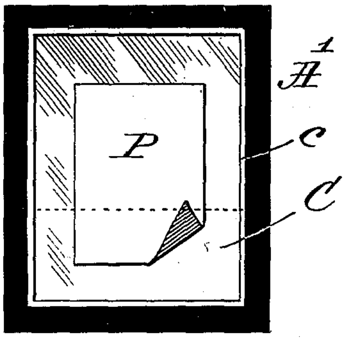


Fig.4.

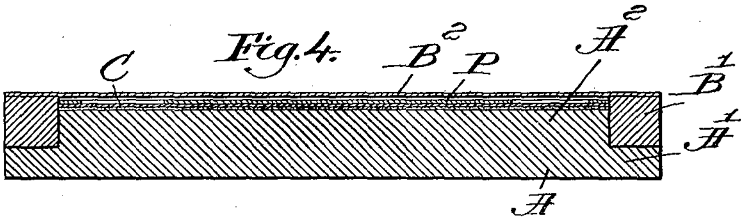


Fig. 6.

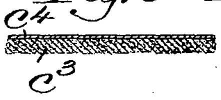


Fig.7.

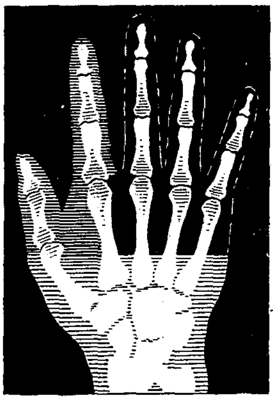
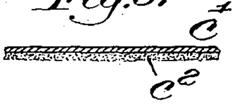


Fig.5.



Witnesses:

A. C. Harmon.
Fred S. Greenleaf

Inventor:

Thomas B. Kinraide
by Crosby Gregory.
attys.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

UNITED STATES PATENT OFFICE.

THOMAS BURTON KINRAIDE, OF BOSTON, MASSACHUSETTS.

METHOD OF AND APPARATUS FOR CONVERTING X-RAYS INTO LIGHT FOR PHOTOGRAPHIC PURPOSES.

SPECIFICATION forming part of Letters Patent No. 595,812, dated December 21, 1897.

Application filed January 15, 1897. Serial No. 619,309. (No model.)

To all whom it may concern:

Be it known that I, THOMAS BURTON KINRAIDE, of Boston, county of Suffolk, State of Massachusetts, have invented an Improvement in Apparatus for and Method of Converting X-Rays into Light for Photographic Purposes, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

In the practical application of the so-called "Roentgen" or "X" rays to photography, especially in connection with surgical and pathological investigation, it is desirable and indeed essential that the photograph should be taken without extreme delay. In many instances the service of the cathode-ray is desired to locate a malformation or a foreign substance under circumstances when the life of the patient would be seriously jeopardized by fatigue, so that it is of the first importance that the results of the investigation shall be secured in the very shortest time possible. As at present devised, however, all X-ray apparatus requires considerable time of exposure, as well as various requirements as to favorable conditions, &c., so that not only is the practical use of this remarkable physical agent hampered, but it is restricted by the force of circumstances to those cases in which delay makes little difference.

It is the object of my invention to enable the operator to secure a superior photograph or skiagraph of the part desired in a much shorter time than has heretofore been possible.

The process at present employed makes use of a phosphorescent and fluorescent screen made of various materials which it is unnecessary to enumerate here, this screen being placed between the source of the rays and the photographic plate or medium for receiving the impression. The result is that the resulting picture is extremely unsatisfactory, due to the unevenness of the screen, it being impossible to make a screen with absolute evenness of thickness and density. The rays in passing through the thick portion produce very different effects on the sensitized paper from that produced in passing through the thin portion, and the photograph has therefore a mottled and confused appearance. Inasmuch as the practical value of these X-ray photographs depends upon the accuracy with which different densities of physical structure can be estimated therefrom, it is of the utmost importance that the tones or shades of the photograph should vary precisely as the densities of the different parts of the medium being photographed and through which the X-rays pass in making the photograph, and that the latter should not be distorted by reason of the uneven and necessarily mechanically imperfect screen. My invention meets this requirement perfectly. By my invention, moreover, the detail of definition in the resulting photograph is remarkably accurate and delicate, approaching in this respect ordinary photographs.

According to my invention the photograph is made by rays passing through the medium being photographed and making its impression directly on the sensitized plate or paper, the rays, however, being clarified or reinforced by means of a fluorescing converter placed beyond the sensitized plate. No screen is used—that is to say, the rays are not passed through any fluorescent medium or screen interposed between the sensitized plate and the source of the rays—but upon passing through the object being photographed the rays are directed immediately upon the sensitized plate and their effect is augmented or reinforced, so to speak, by means of a fluorescent medium placed back of the plate.

My invention will be more fully apprehended in the course of the following detailed description thereof, reference being had to the accompanying drawings, illustrative of my improved method and the means for carrying it out.

In the drawings, Figure 1 is a top plan view of the apparatus for converting the X-rays, showing the same in process of photographing a hand placed thereon. Fig. 2 is a bottom plan view of the cover removed. Fig. 3 is a top plan view of the converting apparatus with the cover removed, showing a piece of sensitized paper in position thereon to receive the photograph. Fig. 4 is an enlarged vertical cross-section taken on the dotted line, Fig. 3. Fig. 5 is an enlarged detail in cross-section of the mirror-like ray-converting plaque or surface. Fig. 6 is a similar enlarged detail of a modification. Fig. 7 represents, on a reduced scale, a photograph which for convenience of illustration indicates in three sections—viz., the lower part, right-hand upper part, and left-hand upper part, respectively—the appearance of a photograph by the old method, by my improved method, and by my improved method when the photograph is held between the observer and the light.

The apparatus by means of which I carry out my invention is extremely simple, and for convenience of description is herein shown as comprising a base or body portion A, having reduced inset edges A' and a central raised portion A^2, and a cover B, comprising a rim or flange B', adapted to fit snugly down against the inset edges A', and a preferably flexible rest or closure B^2.

The rest or closure B^2 may be pasteboard, ebonite, or any other thin and preferably flexible substance, and the entire cover, as well as the surfaces of the inset edges, will be stained or painted a dead black to effectually prevent all entrance of external light to the sensitized paper.

On the raised portion A^2 of the base I spread a converting-surface C, secured thereon by any convenient means, as by a narrow frame c, by tacks, or any other suitable means. As shown in Figs. 3, 4, and 5, this converting-surface comprises a front c' of translucent material—such, for instance, as celluloid—this material being extremely serviceable on account of its translucent quality, durability, lightness, and strength, and on the under side thereof is deposited a coating c^2 of some fluorescent salt, preferably calcium tungstate, put on in a paste or embodied in a gelatin or other vehicle, made as hereinafter described.

Of course gelatin or any other translucent vehicle pervious to the rays may be used instead of the celluloid, inasmuch as its object is to support and protect the exceedingly expensive and easily-destroyed calcium tungstate which I prefer to use as the fluorescent medium. I have found it desirable in certain instances to use the calcium tungstate or other chemical constituent without any separate front c', and I have shown this structure in Fig. 6, in which c^3 denotes a gelatin vehicle in which the chemical is thoroughly mixed, and is then rolled out into a thin even sheet and allowed to harden, and is subsequently coated on its upper surface with a coating c^4 of white varnish, collodion, or other protector, providing a translucent surface for the fluorescent coating or composition.

A converting-surface such as I have last mentioned may be readily made of gelatin, placed on a glass surface polished with French chalk, allowed to harden, and then stripped off, as is commonly done in certain well-known processes in photography.

I am aware that it has been proposed in ordinary photography to provide the usual sensitive-plate with a fluorescent layer between the glass and the emulsion for the purpose of preventing halation and solarization, and I disclaim the same, my invention having nothing to do with "photography," as the term is popularly understood, but, on the contrary, having to do with the X-rays producing photographs, or, more properly, radiographs, by transmitted light or rays depending upon the atomic weight of the object through which the rays pass. Moreover, by the so-called "flourescent" material used in the emulsion on the glass plate mentioned in the last paragraph was meant material fluorescent in the sunlight, whereas the X-ray fluorescence with which my invention has to do is not responsive to light—*i. e.*, to sunlight—the word "fluorescence" being, in fact, incorrect or at least misleading for this reason, inasmuch as it had already been appropriated by physicists before the Roentgen discoveries to mean something else—namely, a certain responsiveness to light. The material proposed to be used in the emulsion was quinine, the object being to do away with the actinic effect of certain rays of the spectrum, whereas in my invention quinine would be entirely useless, with no effect whatever, the invention having nothing to do with the spectrum or with light rays and the object being to increase or rather occasion actinic effect.

While I have described above the preferred details of the mechanical embodiment of my invention, yet I do not intend in any way to limit myself thereto, inasmuch as my invention may be carried out in a wide range of mechanisms. It is obvious that the form of almost any of the usual plate-holders and roll-holders commonly used in photography is adapted by very slight changes to the purposes of my invention.

The particular frame or means of supporting and utilizing my improved converter or converting-surface is a subordinate part of my invention, and therefore I do not restrict myself in any respect thereto.

The novel method by which I proceed to take the improved photograph or cathode picture and in which I use my improved apparatus, above described, is as follows: The Crookes tube or other source of the X-rays is set up in front of the part or substance which it is desired to photograph, and for purposes of illustration we will suppose that this is a human hand, and the apparatus, containing a sheet of sensitized paper P, having its sensitized surface turned against the converter C, as shown in Fig. 3, is placed against the hand, preferably with sufficient pressure to spring the flexible closure or rest B^2 in immediate contact with the paper. The rays pass through the hand and act upon the sensitized paper, which may be superior bromid paper or other extremely sensitive paper or plate, acting thereupon in the usual manner, so that if my apparatus were not used the appearance of the photograph would be as is indicated in the lower part or wrist portion of the photograph represented in Fig. 7. However, the converter C receives those rays which reach it and sets up an intermolecular action or agitation, which may be said to convert these rays into light-giving rays, and these in turn affect or reaffect the bromid surface, or perhaps this may be stated in more accurate terms by simply saying that it reinforces the X-rays and thereby produces an intensified effect, such as is indicated in the upper portion of Fig. 7.

For the purposes of this patent it is unnecessary to enter into a discussion of whether this action is chemical or physical. The effect is that the same length of exposure which is given to produce the indefinite and obscure lower half of Fig. 7 produces by my method and apparatus the superior and definitely-detailed upper portion of said figure. In other words, the detail of definition is heightened and effects of the lights and shades are strongly reinforced or perhaps exaggerated, a further result being also that whereas in the ordinary cathode picture irregularities in thickness and contour of the bones are not brought out, this being clearly shown in the lower half of Fig. 7, by my process the photograph clearly represents all the details, not only of profile shape, but of differences in thickness or general shape, and also another remarkable result is that the picture or photograph which when viewed by reflected light appears as shown in the upper right-hand part of Fig. 7, in which the flesh of the hand is scarcely discernible in the slightest degree, yet when viewed by holding the photograph between the observer and the light the details of the flesh are clearly discernible, as is shown in the illustration of the forefinger and thumb, Fig. 7.

Not only is the force or effect of the X-rays on the photographic film or sensitive substance increased or reinforced by my method, as above explained, but, what is perhaps of still more importance, the photograph represents with absolute accuracy the variations of homogeneity of the tissue or substance being photographed and whose internal composition and arrangement it is desired to study. This is of extreme value in studying pathologic modifications. Furthermore, in order to get as good results as have heretofore been attained—that is to say, such results as are indicated in the lower part of Fig. 7—it is not necessary by my method to give nearly the length of exposure which is at present required, thereby enabling the physicist or surgeon to utilize this remarkable agent in extremely critical cases where otherwise its use would have been unwarranted.

My method as above outlined directs the X-rays against an absolutely even and uniform surface of the convertant or fluorescent material, the rays presumably penetrating this substance to a uniform extent, and thereby obviates all the disastrous and unscientific results of the old processes, which required the X-rays to pass through a screen of necessarily unequal density and irregular surface at one side or the other.

By the term "fluorescent surface" or "converter," as herein used and employed in the claims, I do not restrict my invention to a technically so-called "fluorescent salt" as constituting the active ingredient, nor to any actual conversion or transformation of the X-ray, inasmuch as I intend to include any chemical, crystal, or other substance which produces the effects at present popularly denominated in this connection as "fluorescence" by the journals and papers of the day, and it will be understood also that I use the term "X-ray" in its popular sense, to denote the inductive waves, or it may be violet or ultraviolet waves or longitudinal vibrations, which are variously termed "cathode rays," "anode rays," &c., by investigators, and which is presumably a condition of electric force, ether, or other manifestation of light.

Having fully described my invention, what I claim, and desire to secure by Letters Patent, is—

1. The herein-described method of taking an X-ray radiograph, which consists of interposing the object to be copied and a photographic plate or substance between the source of the X-rays and a surface or converter which transforms the invisible X-rays into light, substantially as described.

2. The herein-described method of taking an X-ray radiograph, which consists of placing a sheet of photographic substance upon an X-ray-converting surface, and interposing between said photographic substance and the source of the X-rays the object to be radiographed, substantially as described.

3. An X-ray apparatus comprising a base, and a plane surface thereon translucent to X-rays, said surface having a coating or composition of material capable of transforming the invisible X-rays into visible actinic light, substantially as described.

4. An X-ray apparatus comprising a base, a translucent surface thereon, said surface having a coating thereon of material capable of transforming the invisible X-rays into visible actinic light, and a removable cover therefor, substantially as described.

5. An X-ray apparatus comprising a base, a translucent surface thereon, said surface having a coating thereon of material capable of transforming the invisible X-rays into actinic light, and a cover therefor, said cover having a flexible rest, substantially as described.

6. A fluorescent surface for use in X-ray work comprising a layer of non-sensitive material translucent to the X-ray, and a layer containing a substance united therewith capable of transforming the invisible X-rays into visible actinic light, substantially as described.

7. A fluorescent surface for X-ray work comprising a sheet of celluloid, and a backing united thereto containing material capable of transforming the invisible X-rays into actinic light, substantially as described.

8. A fluorescent surface for X-ray work, comprising a sheet of celluloid, and a composition of gelatin and a substance united therewith capable of transforming the invisible X-rays into actinic light, substantially as described.

9. In X-ray apparatus, a surface, comprising a gelatin vehicle and a substance carried thereby capable of transforming the invisible X-rays into visible actinic light, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

THOMAS BURTON KINRAIDE.

Witnesses:
JOHN C. EDWARDS,
GEO. H. MAXWELL.

No. 774,759. PATENTED NOV. 15, 1904.

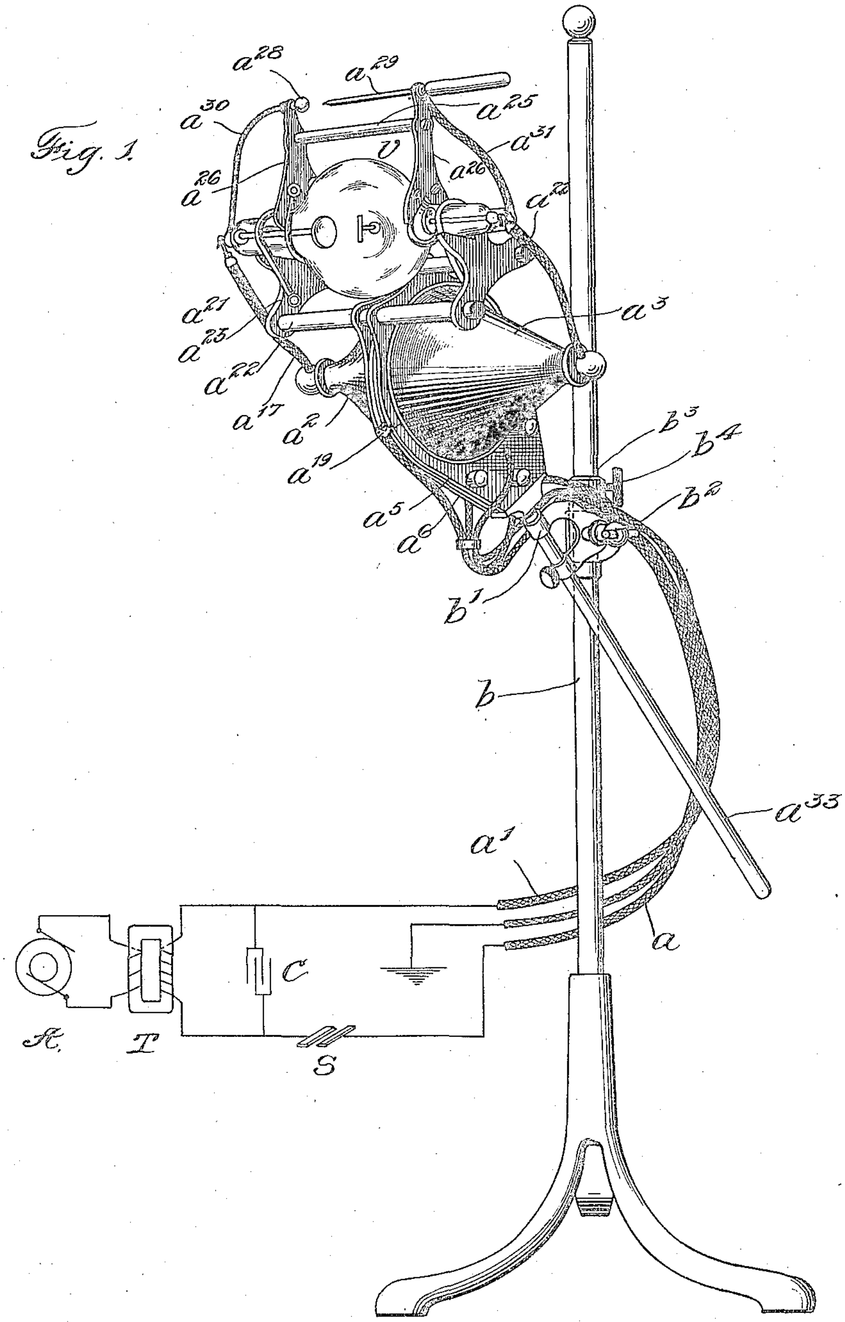
T. B. KINRAIDE.

PORTABLE HIGH FREQUENCY DEVICE AND VACUUM TUBE STAND.

APPLICATION FILED JUNE 27, 1904.

NO MODEL. 2 SHEETS—SHEET 1.

Fig. 1



Witnesses,
John E. Porter
Robert Ringrose.

Inventor,
Thomas B. Kinraide,
by Geo. H. Maxwell,
Attorney.

No. 774,759. PATENTED NOV. 15, 1904.

T. B. KINRAIDE.

PORTABLE HIGH FREQUENCY DEVICE AND VACUUM TUBE STAND.

APPLICATION FILED JUNE 27, 1904.

NO MODEL. 2 SHEETS—SHEET 2.

Fig. 2

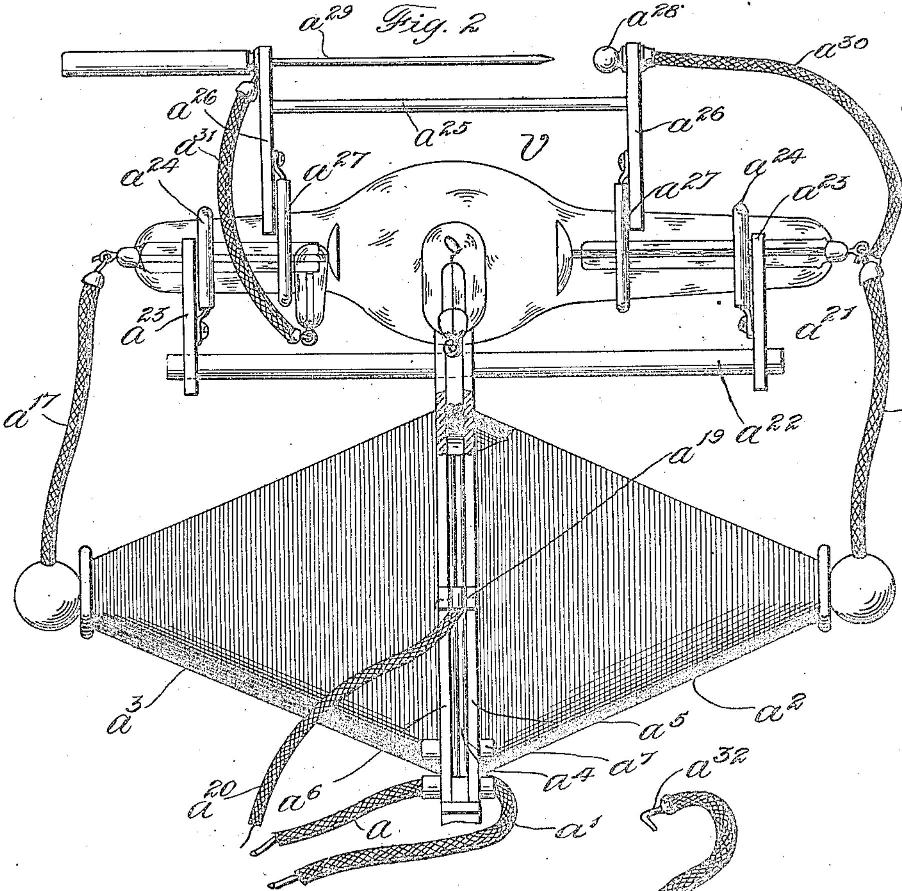
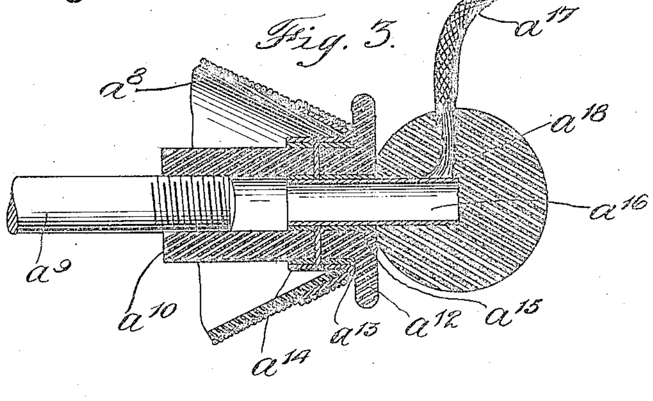


Fig. 3.



Witnesses,

John E. Porter

Robert Ringrose.

Inventor,

Thomas B. Kinraide.

by Geo. H. Maxwell

Attorney.

No. 774,759. Patented November 15, 1904.

UNITED STATES PATENT OFFICE.

THOMAS B. KINRAIDE, OF BOSTON, MASSACHUSETTS.

PORTABLE HIGH-FREQUENCY DEVICE AND VACUUM-TUBE STAND.

SPECIFICATION forming part of Letters Patent No. 774,759, dated November 15, 1904.

Application filed June 27, 1904. Serial No. 214,266. (No model.)

To all whom it may concern:

Be it known that I, THOMAS B. KINRAIDE, a citizen of the United States, and a resident of Boston, Massachusetts, have invented an Improvement in Portable High-Frequency Devices and Vacuum-Tube Stands, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

My invention is an apparatus for enabling a vacuum-tube or the like to reach the highest efficiency in connection with high-frequency currents of high potential, my invention being particularly intended for therapeutical purposes.

The transmission of high-potential currents along long conductors is very wasteful. For instance, in the ordinary static machine the transmission from the machine to an X-ray tube causes a loss of considerably over fifty per cent., and it is well known that high-potential current is very difficult to transmit without a great loss by atmospheric conduction, and this is still more true of high-frequency alternating current, the difficulty being greatest, and hence the waste of current greatest, with the strictly high-frequency currents of induction apparatus. The loss, and hence the difficulty of transmission, increases with the increase of frequency, so that in therapeutical work (for which my invention is particularly adapted, as above mentioned) it becomes practically impossible to transmit the effects from the ordinary high-frequency apparatus to the patient or other object, even ten feet of the best insulated conductor practically dissipating the output. The result is that the so-called "high-frequency" apparatus falls far short of producing proper high-frequency results. Another serious objection resulting from the transmission of this high-potential current over long conductors (as heretofore necessary) is the danger to the patient, apparatus, and operator from the heavily-charged conductor-wires, and hence requiring great skill in their handling and a constant nervous strain upon the operator in doing so.

My invention has for its objects the obviating of the aforesaid difficulties and objections by providing an apparatus which can be operated without any danger to the patient or anxiety on the part of the operator, requiring little skill or technical knowledge in its use, working with very slight dissipation of current, and at the same time not being liable to break down or give out with careless handling. Besides, my invention provides a superior current and is attractive in appearance and convenient to manipulate.

Stated broadly, my invention, so far as it relates to the avoidance of loss of current, resides in mounting the X-ray tube directly on the secondary itself, thereby eliminating the usual conductors, inasmuch as the terminals of the secondary are directly connected with the terminals of the X-ray tube, and that feature of my invention which resides in its convenient portability consists in operating the high-frequency induction device—*i. e.*, the induction-coil, resonator, or the like—at a distance from the high-frequency generator, so that all the heavy portions of the apparatus remain stationary, while the induction device and tube are mounted together for direct use wherever required.

Other features of my invention and the various constructional details of the invention in its embodiment as herein shown will be pointed out in the course of the following description.

In the drawings, in which I have shown one only of many embodiments of my invention, Figure 1 is a perspective view thereof. Fig. 2 is a view in elevation looking at the rear side of the apparatus as shown in Fig. 1. Fig. 3 is an enlarged sectional detail showing the construction of one of the terminals of the apparatus.

This invention relates to high-frequency apparatus of the most advanced type, and by the terms "high frequency" and "high potential" as herein used I refer to currents capable of producing a disruptive or brush discharge into the air from spherical electrodes at least one inch to one and one-half inches in diameter, or, defined otherwise, my invention relates to currents which cannot be conducted (at least not in the usual manner) over a conductor-wire, as commonly practiced with ordinary currents, but will dissipate themselves in the air in spite of any usual insulation. This high-frequency high-potential current because of the impossibility of conducting it has heretofore been incapable of practical and successful use for such purposes as those hereinbefore mentioned, because almost entirely lost in the air before reaching the translating device, (at the patient, for example,) said dissipation being, moreover, exceedingly dangerous to the operator; and it is the object of my invention to render available without danger or loss of current the kind of current which I have just defined. I have succeeded in securing the desired result, not by rendering the current any more transmissible than before, but by separating the essential parts of the apparatus in such manner and providing such construction that the exceedingly high frequency and high-potential current, with its attendant danger and difficulty, need not be transmitted, but is developed directly at and in connection with the portable translating device operated by a stationary and remote generating source comprising the heavier and more cumbersome portions of the apparatus, which are capable of transmitting without danger to the portable portion the proper current for operating the latter to produce the dangerous and non-transmissible current first defined.

The high-frequency generator or source of high-frequency current may be of any usual or preferred kind, being herein diagrammatically represented as comprising an alternator A, transformer T, condenser C, spark-gap S, (the latter being indicated as of the kind contained in my application Serial No. 209,686.) From this source of high-frequency energy conductors *a a'* lead to the "tube-stand," (by which term I mean to include any device carrying the vacuum-tube or other translating device.) As herein illustrated said tube-stand is mounted for convenience on a standard or rod *b*. As already stated, the tube-stand consists of a "high-frequency" device, (by which term I mean to include any device capable of high-frequency discharge,) and, as herein shown, this high-frequency device is composed of two conical secondaries a^2 a^3, extending coaxially in opposite directions from a common primary a^4. The general construction and advantages of the conical form of secondaries are set forth in my copending application, Serial No. 209,684, filed May 25, 1904. While I do not limit my invention to any definite use or capacity, a convenient construction includes a coarse winding of four turns, whose terminals connect to the respective conductors *a a'*, and a fine winding of No. 30 triple-wound secondary.

The bases of the secondary coils are arranged adjacent to each other and separated from the common primary a^4, wound in a peripheral groove formed between plates a^5 a^6 and held in rigid position by suitable means, as bolts a^7. These secondaries are wound on hollow insulating shells or supports a^8 and held together by a tie-rod a^9 passing through the plates a^5 a^6 and having threaded engagement at its ends with opposite ferrules a^{10}, (one only being shown in Fig. 3, as the construction is the same at the opposite ends of the apparatus,) whose heads a^{12} engage the outer ends of the cones a^8, thereby clamping the high-frequency device together. At their smaller ends each cone is provided with a conductor-plate a^{13}, connected by a pin or strip of conductive material a^{14} to a contact-plate a^{15} for tightly receiving a metal sleeve or post a^{16}, to the outer end of which is soldered or suitably secured the secondary-terminal a^{17}, as indicated at a^{18}, within a ball of insulating material. The opposite terminals of the two secondaries are connected together, as indicated at a^{19}, and grounded by a wire a^{20}.

The plates a^5 a^6 carry a frame a^{21}, shown as comprising a pair of rods a^{22}, supported in said plates, and end supports a^{23}, notched at their upper ends, as plainly shown in Fig. 1, for receiving the vacuum-tube V or other translating device operated in connection with the apparatus. In the drawings I have shown one well-known form of X-ray tube as mounted in the frame a^{21}, said tube being held in position by heavy rubber straps a^{24}, connected at their free ends to the supports a^{23} and passed yieldingly about the ends of the vacuum-tube. On the latter is a bridge-frame consisting of a rod a^{25} and inverted-**Y** supports a^{26}, held in place by heavy rubber straps a^{27}, similar in construction and arrangement to the straps a^{24}. This bridge-frame carries opposite electrodes a^{28} a^{29}, connected by wires a^{30} a^{31} to the vacuum-tube for regulating the vacuum therein in well-known manner. The opposite secondary-terminals a^{17} are provided with hooks a^{32} for quick connection with the translating device.

The tube-stand is provided at its lower end with a handle a^{33}, shown as slidingly mounted in a bracket b', adjustably secured by a hand-screw b^2 to a slide b^3, clamped by a thumb-screw b^4 to the standard *b*.

In use it will be seen that, in the first place, the X-ray tube is mounted directly on the high-frequency device instead of being mounted at a distance on a separate stand, as has heretofore been the practice. By this means separate conductors are entirely eliminated, it being necessary merely to extend the terminals proper of the high-frequency device the short distance required in order to reach the translating device, mounted as close thereto as the shape of the respective parts will permit. By this means the energy of the high-frequency device is not dissipated, but is directly transferred to the X-ray tube, thereby giving an efficiency hitherto not obtainable. In the next place, the high-frequency device is light and portable, inasmuch as the heavier parts of the apparatus are separated therefrom, being ordinarily kept in a heavy cabinet considerably removed from the operating chair, table, or, it may be, from the room itself.

By the arrangement of the mechanism herein set forth as the preferred embodiment of my invention one primary serves for two secondaries, and also by having the secondaries arranged as shown, in which a single layer of fine wire is provided, the liability of sparking from turn to turn is eliminated and the discharge-terminal is removed from the primary, the resistance decreases with each turn, and it is possible to get more turns than in any other form with a single layer, &c., as explained in my before-mentioned conical-coil application.

The yielding holders a^{24} a^{27} permit the translating device to be turned readily without disarranging the connections, as has heretofore been necessary.

As already intimated, I do not intend to restrict myself to the precise construction herein set forth as the preferred embodiment of my invention, as many changes in form, arrangement, and relation of parts may be resorted to without departing from the spirit and scope of my invention as defined in the broader claims hereinafter contained. I regard my invention as broadly new in a number of particulars, as will appear more definitely in the following claims.

My invention has no relation in any way to low-frequency hand devices and portable cabinets operated by primary batteries and the like nor to the induction devices which were commonly used in connection with ordinary currents a few years ago, but is restricted to that class of apparatus, as previously defined, of which the current is of such a high frequency and high potential as to be practically non-transmissible, for the reasons already stated, over a usual conductor, said current having a high frequency and high potential capable of a disruptive brush discharge, as already stated.

Having described my invention, what I claim as new, and desire to secure by Letters Patent of the United States, is—

1. The herewith-described means of rendering the described kind of current available with the highest efficiency directly at the point of use, consisting in the combination of a stationary generating source of high-frequency current, with an independently mounted and inclosed device capable of developing therefrom a high-potential and high-frequency current of the kind described, said device being capable of hand manipulation for direct application of said current and connected to said stationary source by a long flexible conductor permitting it to be readily moved about the room or patient without disturbing said stationary source.

2. The combination with a stationary source of high-frequency current, of a portable induction-coil operating in connection therewith to develop high-frequency high-potential current of the kind described, and a long flexible conductor supplying current from said source to the primary of said coil.

3. A high-frequency apparatus having a high-potential high-frequency disruptive discharge device movable independently of the rest of the apparatus for permitting local application or the like.

4. In an apparatus of the kind described, comprising a source of high-frequency current, and remote high-frequency device operated thereby, and a frame carried by said device for supporting a translating device in close proximity thereto.

5. In an apparatus of the kind described, comprising a source of high-frequency current, a high-frequency device, having a central partition, terminals at the opposite sides of said partition, a frame carried by said partition transversely thereof for supporting a translating device, and means for connecting the latter directly with said terminals.

6. In an apparatus of the kind described, comprising a source of high-frequency current, a high-frequency device, a flexible conductor engaging the two, means for connecting the terminals of said high-frequency device directly to a translating device, and means for moving said translating device and high-frequency device together.

7. In an apparatus of the kind described, comprising a source of high-frequency current, a high-frequency device, a flexible conductor engaging the two, means for connecting the terminals of said high-frequency device directly to a translating device, and a handle extending from said high-frequency device for adjusting and moving the same and said translating device together.

8. A high-frequency device, comprising a primary, and a pair of independent secondaries operated by said single primary.

9. A high-frequency device, comprising an intermediate coarse primary, and opposite fine secondaries, operated thereby, having their discharge-electrodes remote from said primary.

10. A high-frequency device, comprising a primary, and opposite conical secondaries.

11. A high-frequency device, comprising a conical support, a secondary wound thereon, a peripheral groove at the base of said support, and a primary held in said groove.

12. A high-frequency device, comprising a primary, insulating-plates on opposite sides thereof, opposite secondaries outside of said plates, and retaining means therefor.

13. A high-frequency device, comprising a primary, retaining-plates therefor, opposite

conical secondaries extending coaxially in opposite directions therefrom, and an axial tie-rod binding all of said parts.

14. A high-frequency device, comprising a primary, a conical secondary operated thereby, a tie-rod, a ferrule binding said parts together, said ferrule having external and internal contact-plates electrically connected together and with said secondary.

15. In a high-frequency device, a conical secondary, having a discharge-terminal consisting of a ferrule having an internal contact-plate electrically connected with the smallest turn of said secondary, a removable conductor-post fitting against said contact-plate and having, adjacent the end of said ferrule, a short terminal wire permanently secured thereto.

16. In a high-frequency device, a conical secondary, having a discharge-terminal, consisting of a ferrule having an internal plate electrically connected with the smallest turn of said secondary, a removable conductor-post fitting against said contact-plate and having, adjacent the end of said ferrule, a short terminal wire permanently secured thereto in a ball of insulating material.

17. A high-frequency device, having a frame mounted directly thereon, and provided with means for securing a vacuum-tube thereto.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

THOMAS B. KINRAIDE.

Witnesses:
GEO. H. MAXWELL,
E. G. PROCTOR.

No. 774,760. PATENTED NOV. 15, 1904.

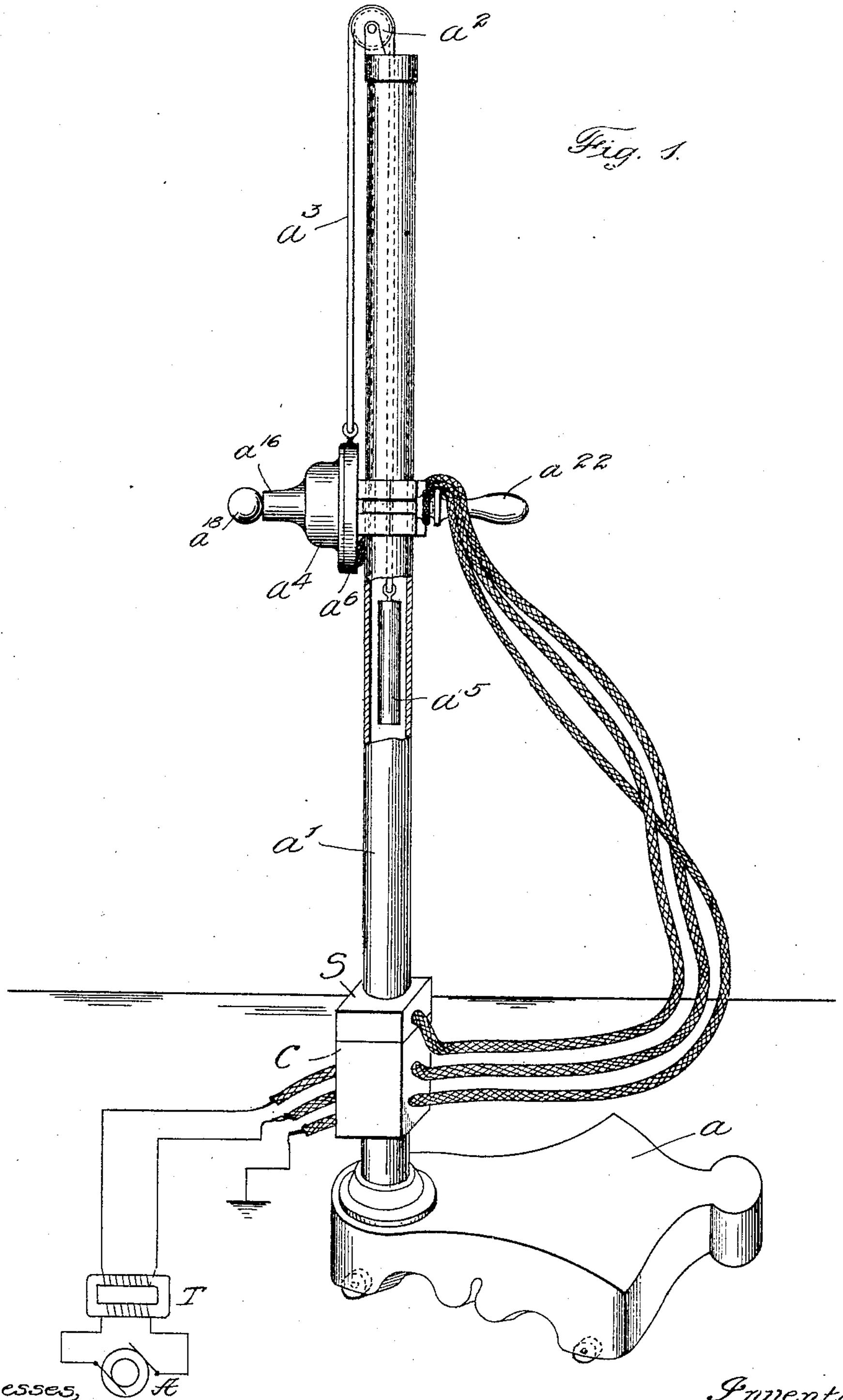
T. B. KINRAIDE.

SELF CONTAINED HAND ELECTRODE.

APPLICATION FILED JULY 5, 1904.

NO MODEL. 2 SHEETS—SHEET 1.

Fig. 1.



Witnesses,
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Robert Ringrose.

Inventor,
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APPLICATION FILED JULY 5, 1904.

NO MODEL. 2 SHEETS—SHEET 2.

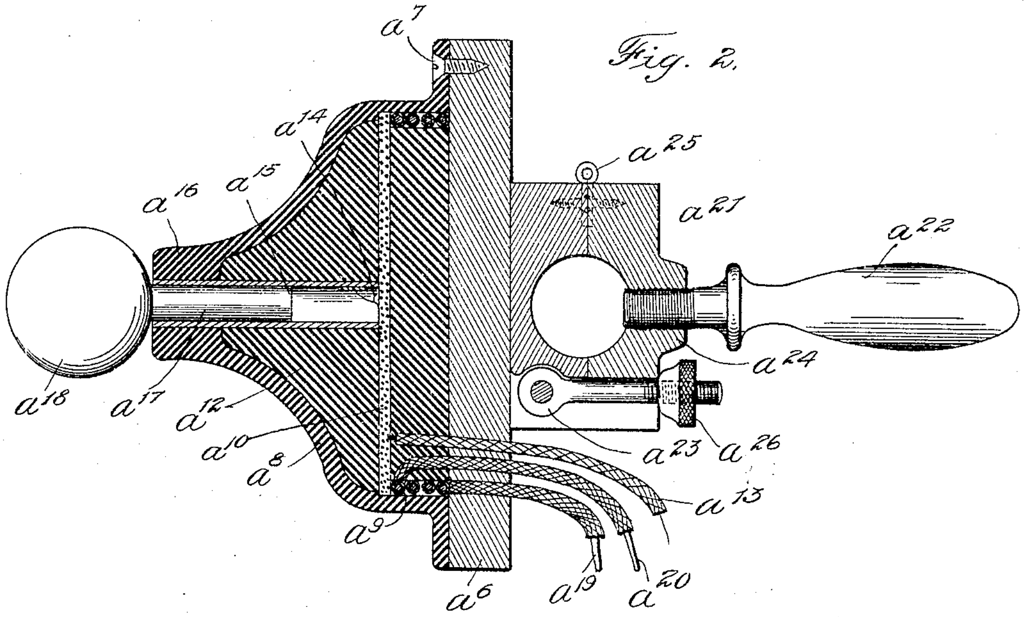

Fig. 2.

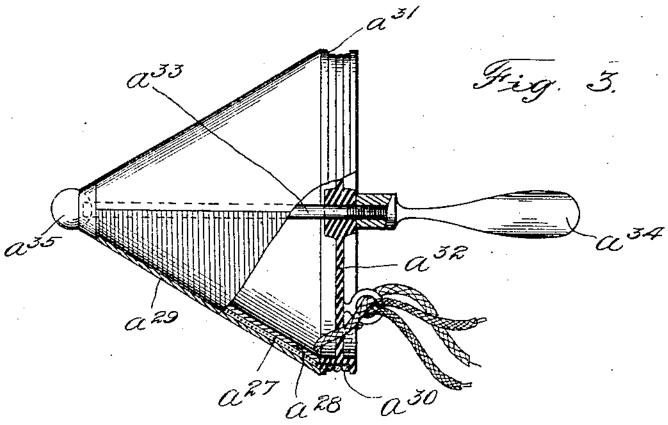

Fig. 3.

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PHOTO-LITHOGRAPHED BY SACKETT & WILHELMS LITHO. & PTG. CO. NEW YORK.

No. 774,760. Patented November 15, 1904.

UNITED STATES PATENT OFFICE.

THOMAS B. KINRAIDE, OF BOSTON, MASSACHUSETTS.

SELF-CONTAINED HAND-ELECTRODE.

SPECIFICATION forming part of Letters Patent No. 774,760, dated November 15, 1904.

Application filed July 5, 1904. Serial No. 215,278. (No model.)

To all whom it may concern:

Be it known that I, THOMAS B. KINRAIDE, a citizen of the United States, and a resident of Boston, Massachusetts, have invented an Improvement in Self-Contained Hand-Electrodes, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

The value and importance of electricity in the treatment of disease have recently gained wide recognition, especially in connection with the employment of high-frequency current. One serious difficulty, however, has been the adaptation or provision of means for rendering it practicable to employ very high frequency currents for local application. One difficulty has been the danger or discomfort likely to attend the application of this kind of current, and another difficulty has been the loss of current due to the action of atmospheric conduction on the conducting-wires leading from the high-frequency device to the patient, and a third serious difficulty has resided in the cumbersome apparatus, it having heretofore been necessary to move the entire generating apparatus to the patient or else move the patient to the apparatus.

It is the object of my present invention to obviate all these difficulties, besides providing various other advantages. I accomplish my object by providing a high-potential high-frequency disruptive discharge device operated by hand and readily movable independently of the generating source of the high-frequency current, so that the operator can manipulate the hand device the same as he has heretofore manipulated the usual hand-electrode and can now do so with my invention without the danger, inconvenience, or loss of current heretofore experienced.

The preferred form of my invention which I have herein shown is especially adapted for prolonged application as a head-terminal or for use above the patient, and I have also shown a form of my invention adapted for short and general application and for delicate manipulation and difficult cases of local application.

In the drawings, Figure 1 is a view in side elevation of one form of my invention. Fig. 2 is a transverse sectional view thereof on the line 2 2, Fig. 1. Fig. 3 is a view in side elevation of a modified form, parts being broken away for clearness of illustration.

One of the distinctive features of my present invention is the provision of a hand-electrode constituting in itself a high-frequency device, Figs. 1 and 2 showing the same as capable of being moved by hand up and down on a standard or removed therefrom and handled separately and Fig. 3 showing a lighter form of device for hand use only.

I wish it understood that my invention is restricted to high-frequency high-potential current of the kind previously mentioned, by which I mean current of such enormous frequency and high potential that it cannot readily be conducted because of its tendency to discharge into the air in spite of any usual insulation, my invention residing in providing means whereby that portion of the apparatus which is to be carried or moved by the hand of the operator is separated from the rest of the apparatus and contains within itself that portion of the winding or other mechanism which serves to transform the high-frequency transmissible current into the kind of current which is not transmissible and which I have defined as a high-frequency high-potential disruptive discharge-current.

On a suitable base a is rigidly secured a hollow standard a', provided with a pulley a^2, swiveled at its upper end, over which passes a cord a^3, carrying a hand-electrode high-frequency device a^4 at its outer end and a counterbalance-weight a^5 at its inner end.

The electrode a^4 comprises a back piece a^6, to which is secured at a^7 a shell of hard rubber or the like a^8, containing a coarse primary a^9, wound adjacent the outer turns of a flat secondary a^{10} of the form shown in my patent, Serial No. 615,653, of December 6, 1898, all embedded in insulating material, such as hard wax a^{12}, poured therein in melted condition. One terminal, a^{13}, of the secondary is shown as grounded, and the other or inner terminal, which constitutes the high-potential discharge-terminal of the secondary, is connected at a^{14} to a tubular contact device a^{15}, permanently secured in the pointed end a^{16} of the high-frequency device for receiving any desired form of discharge-electrode, the shank a^{17} of a ball-discharge electrode a^{18} being herein shown as mounted therein. The terminals of the primary are connected by suitable flexible conductors a^{19} a^{20} to a suitable source of electrical energy, shown as comprising a generator A of alternating current, whose conductors lead to a transformer T, connecting with a condenser C and spark-gap S. In my copending application, Serial No. 214,266, I have explained more at length the advantages of having the high-frequency device separated from the generating source, and in the present arrangement I have separated the parts still farther, the alternator and transformer, which serve to generate the low-frequency high-voltage current and which constitute the heavier portions of the generating apparatus, being separated a long distance from the movable portion of the apparatus, and the condenser and spark-gap, which serve to raise the low-frequency current to a high-frequency current, being mounted, preferably, directly on the standard a', thereby bringing as near to the discharge-electrode as practicable all that portion of the current which has any tendency to dissipate itself in the atmosphere by conduction. This also brings all the adjustable parts of the apparatus directly to the hand of the operator.

The arrangement as thus described is of great importance in therapeutical work, because it makes it possible to use the highest frequency and most powerful and efficient current without deterioration wherever it is desired to quickly shift the electrode, as the surgeon can readily move the standard a' here and there about the room without any inconvenience, the heavy generating parts being connected by long conductors and located in a closet or other convenient place, and as the operator is using the apparatus he can instantly adjust the hand-electrode up or down or sidewise and likewise adjust the spark-gap or condenser, all without leaving the patient or otherwise interrupting the treatment.

The back a^{6} of the high-frequency device is provided with a clamp a^{21} and operating-handle a^{22}, said clamp being shown as consisting of two blocks a^{23} a^{24}, hinged at a^{25} and locked together by a thumb-nut a^{26}, although I do not restrict myself in any way to the means which may be provided for retaining the high-frequency device movably upon its standard.

From the above description it will be understood that the high-frequency generator may be located in the corner of the room or elsewhere, as desired, transmitting the current generated thereby to the high-frequency device over the conductors a^{14} a^{20} without danger or material loss of current, inasmuch as the form of the current as delivered from the source mentioned is of such well-known character that it is readily restrained by the ordinary insulation provided with good conductor-wires. The current having been delivered properly to hand-electrode a^{4}, which I have denominated the "high-frequency device," is raised by the latter to the enormous frequency and high voltage required for the disruptive discharge desired in this class of apparatus, and by my invention the high-frequency device itself is the electrode and is movable directly to the position required for local application. The truck or standard is readily moved to the operating-table or wherever required, and the hand device is swung on the rod a' to any direction desired and is readily raised or lowered. This, for instance, enables it to be used with a head-terminal for prolonged application, which would otherwise be practically impossible with the ordinary apparatus because of the fatigue resulting to the operator, whereas by my invention the operator is relieved of all fatigue and also the element of danger, and hence nervous anxiety on the part of the operator is practically eliminated, inasmuch as there are no conductor-wires from the high-frequency device, (which have heretofore constituted the source of danger.)

In case the application of the high-frequency disruptive discharge is to be of short duration, and especially if the application is to be with reference to an awkward position, the operator simply unclamps the device a^{4} from its standard and holds it in his hand to the spot desired. For the latter purpose I also provide a lighter form of construction, as shown in Fig. 3, where it will be seen that I have provided a conical secondary a^{27}, wound on a light supporting-shell a^{28}, and preferably inclosed by an outer cone a^{29}, the primary a^{30} being wound in a peripheral recess or groove a^{31}, provided in a base a^{32}, the parts being held together in any desired manner, as by a rod a^{33}, having threaded engagement with the handle a^{34} and adapted to receive any kind of a discharge-electrode at its opposite end, as a ball a^{35}. This form of hand device is light and well adapted to general use and lends itself to more delicate manipulation than the heavier form of hand devices previously described.

It will be understood my invention is capable of a wide variety of embodiments, as I believe it is broadly new to provide a hand device or electrode which itself produces the high-potential high-frequency current that causes the disruptive discharge delivered by the electrode.

The current supplied to this hand device or hand-electrode is a high-frequency current, but is not of that quality which renders it dangerous and practically non-transmissible, the mechanism which transforms said current into the latter kind of current being contained within the electrode itself, whereby all necessity for further conductors, and hence loss of current and danger, &c., are eliminated, the current not being permitted to assume this condition until it reaches the device which is to be carried or manipulated by the operator directly at the applying-point. I have already pointed out that the current to which my invention relates is not the ordinary current, and I wish to repeat that my invention relates to the most advanced type of high-frequency current known to therapeutical practice at the present day, being distinguished by its ability to produce a disruptive or brush discharge into the air from spherical conductors of one inch to one and one-half inches in diameter. I take this means of defining the character of the current, although it will readily be understood that it can be recognized by various other distinctive features and characteristics, and accordingly I do not intend to restrict myself by these definitions to any arbitrary frequency or potential, but have undertaken merely to explain the field of usefulness and kind of current with sufficient clearness to enable those skilled in the art to apprehend with certainty what my invention is, the difficulties it is intended to overcome, and the advantages effected thereby.

I am aware that it has long been common to employ hand-electrodes; but so far as I am aware these have either been remote from the producer of the form of current discharged or else they have not been capable of delivering the kind of discharge herein provided for. It will therefore be understood that I am not restricted in any way (excepting as specified in the claims) to the constructional details herein set forth.

Having described my invention, what I claim as new, and desire to secure by Letters Patent of the United States, is—

1. A hand device or electrode for hand manipulation at the point of application, comprising a portable inclosure provided with a carrying device adapted to be grasped by the hand, said portable inclosure adapted to be connected to a source of high-frequency current, and containing within itself means for developing from said current a high-frequency high-potential disruptive discharge-current of the kind described.

2. A source of high-frequency current, and portable means for producing therefrom a high-potential high-frequency disruptive discharge-current of the kind described, said means being connected to said source by a long flexible conductor and being light in weight and small in size for carrying by hand and for hand application and manipulation.

3. A standard, provided with a hand-electrode movable up and down on said standard and containing a high-frequency induction device.

4. A portable standard or support, carrying a disruptive discharge-electrode provided within itself with a high-potential high-frequency coil.

5. A portable standard or support, carrying a disruptive discharge-electrode provided within itself with a high-potential high-frequency coil, said electrode being freely movable by hand with relation to said standard.

6. An electrode, containing an induction-coil, a hollow support therefor, on which said electrode is freely movable, and counterbalancing means within said support for said electrode.

7. A high-frequency induction device for therapeutical work, comprising a portable standard, a hand-electrode, containing a high-frequency high-potential induction-coil, mounted movably on said standard, and a generating source comprising a source of alternating current, transformer, condenser and spark-gap, the latter two being mounted on said portable standard and having a short connection to said hand-electrode, and said transformer and source of alternating current being remote from said standard.

8. A high-frequency induction device for therapeutical work, comprising a portable standard, a hand-electrode containing within itself means for producing from an ordinary high-frequency current a high-frequency, high-potential disruptive discharge-current, a condenser and spark-gap in the circuit thereof, mounted adjacent thereto, and a remote source of current therefor including a transformer.

9. In an apparatus in the kind described, a stationary alternator and transformer located remote from the rest of the apparatus, and a high-frequency translating device, spark-gap and condenser located close to each other connected by short conductors for operation in connection with said remote alternator and transformer.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

THOMAS B. KINRAIDE.

Witnesses:
Geo. H. Maxwell,
E. G. Proctor.

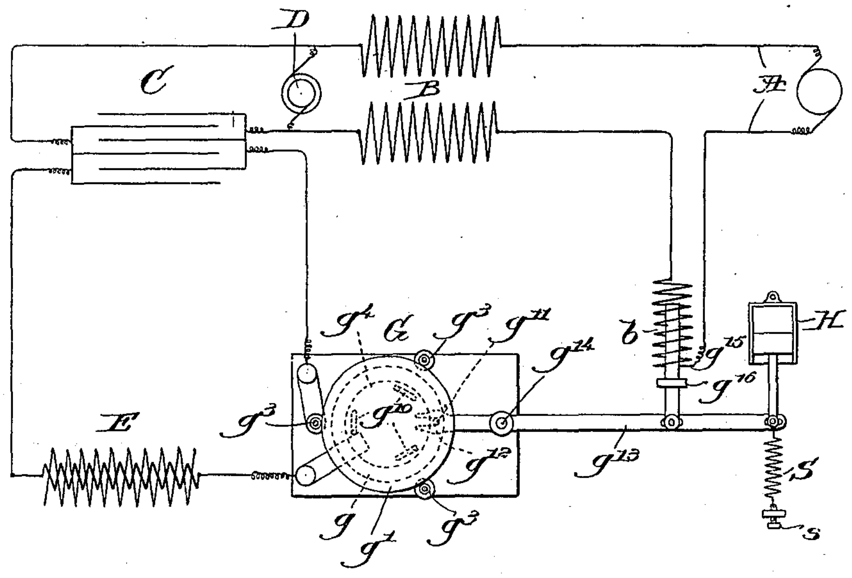
No. 684,828. Patented Oct. 22, 1901.

T. B. KINRAIDE.

SPARK GAP REGULATOR.

(Application filed Mar. 5, 1901.)

(No Model.)



Witnesses,
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Margaret A. Dunn

Inventor;
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by Crosby Gregory,
attys.

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UNITED STATES PATENT OFFICE.

THOMAS B. KINRAIDE, OF BOSTON, MASSACHUSETTS.

SPARK-GAP REGULATOR.

SPECIFICATION forming part of Letters Patent No. 684,828, dated October 22, 1901.

Application filed March 5, 1901. Serial No. 49,702. (No model.)

To all whom it may concern:

Be it known that I, THOMAS B. KINRAIDE, a citizen of the United States, residing at Boston, county of Suffolk, State of Massachusetts, have invented an Improvement in Spark-Gap Regulators, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

The present invention is an automatic regulator for a spark-gap, and is particularly intended for regulating such a spark-gap as is shown in my United States Patent No. 623,318, dated April 18, 1899. The spark-gap shown in the said patent comprises two plates or opposite parallel discharge-surfaces and means for moving one of said plates toward and from the other, said means being operated by a hand-lever horizontally pivoted at one side of the spark-gap, so that upon turning said lever in one direction the air gap or dielectric will be lessened and by turning said lever in the opposite direction it will be increased. This spark-gap has proved to be an exceedingly important piece of apparatus in the high-potential system set forth in my Patent No. 623,316, granted April 18, 1899; but on account of the continual oxidation of the adjacent surfaces of the plates in operation the amperage-discharge, which it is one purpose of this device to keep uniform, is liable to vary, due to the changing resistance caused by said oxidation. Accordingly it has been necessary for the operator to keep constant watch of the apparatus and maintain the plates at proper distances by continual shifting of the regulating-handle, which, however, is not only laborious, but cannot be performed manually with the exactness often necessary.

Accordingly it is the object of my present invention to provide an automatic means for maintaining the spark-gap regular in action according to the operation of the system, said regulator being automatically operated by the current of the general system, so that any change in the latter will instantly effect the requisite change in the spark-gap in order to maintain the discharge uniform.

The constructional details of my invention will appear more fully in the course of the following detailed description, reference being had to the accompanying drawing, in which I have illustrated a preferred form of my invention, and the latter will be more particularly defined in the appended claims, also forming a part of this specification.

In the drawing I have shown my invention partly diagrammatically and largely in top plan view.

As already intimated, my invention relates particularly to the spark-gap, but also becomes an important part of the aforesaid system.

In the drawing the main circuit or conductor is indicated at A, containing in series an inductance-coil B, condenser C, interrupter D, induction-coil or other translating device E, and spark-gap G, the latter comprising, as is stated more fully in my first-mentioned patent, lower and upper plates g g', the upper plate g' resting on adjustable supports g^3, and the lower plate g resting on a support g^4, carried by rocking struts g^{10}. The plate g has a depending pin g^{11}, engaged by the bifurcated end g^{12} of a regulating-arm g^{13}, pivoted at g^{14}, all as contained in said patent. The arm g^{13} is prolonged and is provided with a core g^{15} or armature g^{16}, or both, arranged to be attracted by a coil or solenoid b in series with the main line A. The auxiliary coil b is preferable, and I deem it essential with alternating currents, although the attractive influence of the main current may be obtained in various other ways. In connection with the attractive influence of the coil b I provide a dash-pot or other device H, and a regulating-spring S, controlled by any suitable means, as by a thumb-screw s, operating in opposition to the coil b.

It will be understood that many changes and substitutions within the well-known range of mechanical and electrical equivalents may be resorted to within the spirit of my invention.

The operation of my improved apparatus and system is as follows: When the current is passing normally through the line A, coil B, and discharging from the condenser C across the spark-gap at the amperage and voltage and with the regularity for which the spark-gap and apparatus have been adjusted, the parts remain uninfluenced by the regulator, the spring S and action of the coil B serving to neutralize the effects of each other at such times and maintain an equilibrium. If, however, an increased current or discharge should for any reason occur, the solenoid *b* will instantly attract the lever g^{13}, thereby opening the spark-gap, said movement, however, being retarded by the dash-pot, which serves thereby to prevent an undue opening of the spark-gap, which would otherwise occur. When the current falls and would, therefore, produce an opposite irregularity in the discharge action at the spark-gap, the attractive influence of the solenoid is lessened, thereby permitting the spring S to move the lever g^{13} so as to close or lessen the gap between the plates g g'. In this manner the action of the inductance-coil and condenser are maintained in normal coöperation, or, in other words, the condenser is caused invariably to discharge at the precise maximum charge for which the spring S, coöperating with the armature of the solenoid, is set.

Having described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. In a system of the kind described, including a main-line conductor, condenser, spark-gap, and translating device arranged in series, means actuated by the current of said main-line conductor for automatically maintaining said spark-gap set for a given discharge.

2. In a system of the kind described, a main-supply circuit, a condenser charged therefrom, and a spark-gap consisting of opposite parallel discharge surfaces or plates, movable toward and from each other, means for governing the distance apart of said plates, and a solenoid in series with said supply-circuit for automatically controlling said governing means.

3. A spark-gap comprising opposite discharge-plates, movable toward and from each other, a lever for thus moving said plates, a circuit for supplying the current to be discharged by said plates, a coil in said circuit, means connected with said lever to be attracted by said coil, and regulating means tending to move said lever in opposition to the attraction of said coil.

4. A spark-gap comprising opposite discharge-plates, movable toward and from each other, a lever for thus moving said plates, a circuit for supplying the current to be discharged by said plates, a coil in said circuit, means connected with said lever to be attracted by said coil, regulating means tending to move said lever in opposition to the attraction of said coil, and an adjusting device for adjusting said regulating means.

5. A spark-gap comprising opposite discharge-plates, movable toward and from each other, a lever for thus moving said plates, a circuit for supplying the current to be discharged by said plates, a coil in said circuit, means connected with said lever to be attracted by said coil, and means for retarding the action of said lever.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

THOMAS B. KINRAIDE.

Witnesses:
GEO. H. MAXWELL,
GEO. W. GREGORY.

No. 682,203. Patented Sept. 10, 1901.

T. B. KINRAIDE.

STATIC MACHINE.

(Application filed Mar. 5, 1901.)

(No Model.)

Fig. 1.

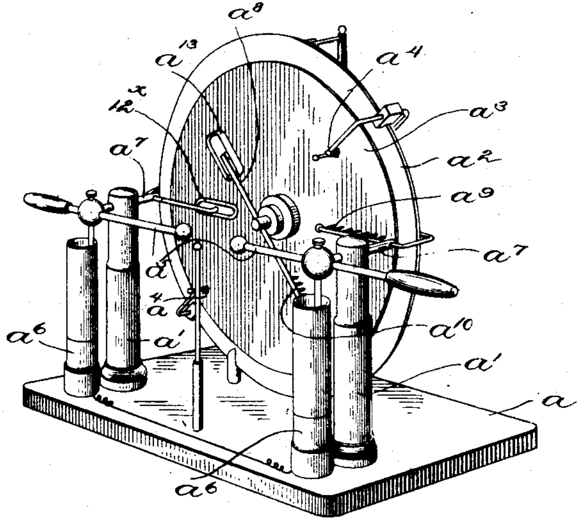
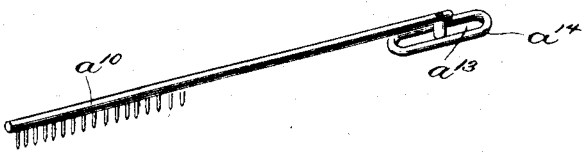


Fig. 2.



Witnesses.
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THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

UNITED STATES PATENT OFFICE.

THOMAS B. KINRAIDE, OF BOSTON, MASSACHUSETTS.

STATIC MACHINE.

SPECIFICATION forming part of Letters Patent No. 682,203, dated September 10, 1901.

Application filed March 5, 1901. Serial No. 49,703. (No model.)

To all whom it may concern:

Be it known that I, THOMAS B. KINRAIDE, a citizen of the United States, residing at Boston, in the county of Suffolk and State of Massachusetts, have invented an Improvement in Static Machines, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

As is well known, the usual static machine is very uncertain as to its polarity, being liable to reverse at any moment and keep changing irregularly according as the electrical balance is disturbed; and accordingly it is the purpose of my present invention to provide means for effectually preventing the said reversal and maintaining the parts under such condition that one pole will always be negative and the other pole always be positive.

The constructional details of my invention will be pointed out in the course of the following description and the operation thereof fully set forth, and the invention will be particularly defined in the appended claims.

In the drawings, Figure 1 represents a typical form of influence or static machine provided with my invention. Fig. 2 is a perspective view of a portion thereof.

For convenience of illustration I have represented in the drawings a form of the Toepler-Holtz machine, although it will be understood that my invention is applicable to any kind of static machine.

The machine herein shown is well known and therefore need not be minutely described. In general it comprises, so far as the parts are shown in the drawings, a base a, standards a', glass plate a^2, and one or more ebonite or glass plates a^3, in connection with brushes a^4, discharge-rods a^5, condensers or Leyden jars a^6, conductors a^7, and a short-circuit rod a^8. As formerly constructed the two conductors a^7 have been provided at their inner ends with similar combs, the same as is shown at a^9 and a^{10} in the drawings, the result being that either pole of the machine would give or take electricity with equal freedom, and hence one pole might be the positive collector of the machine at one moment and negative at the next moment, the machine reversing and discharging back without control. I have discovered, however, that by having a plane receiving-electrode a^{12} a^{13}, or, as it may be termed, an electrode having a large flat area constructed without tendency to discharge, said electrode or electrodes being located at the positive region of the machine, and by having the usual comb-like electrode or electrodes at the negative region of the machine the latter will be under exact control and will maintain the proper direction continuously. The general form of electrode which I prefer to employ is that fully described in my copending application, Serial No. 26,709, filed August 13, 1900, and, as herein shown, the same has a plane surface next to the moving field a^3 and an elongated radially-extending shape, as is clearly shown in both figures, the edges thereof being rounded or rolled outwardly and inwardly, as is clearly shown at a^{14}, Fig. 2.

In operation a machine constructed as above explained operates as follows: The positive electricity passes invariably from the plate a^3 to the electrode a^{12} and from the electrode a^9, the same operation also taking place through the neutralizing or short-circuiting rod a^8, the positive electricity passing to the end a^{13} and out at the end a^{10}, and a reversal cannot take place, for the reason that there is always a decided opposition to any discharge from the electrode a^{12} to the plate, whereas there is comparatively no opposition at the opposite end a^9, or, in other words, the terminals are provided, respectively, with forms of receiving and discharging electrodes best adapted, respectively, to receive without discharging and to discharge without receiving the static charge.

My invention is by no means restricted to the form herein shown, as it may be embodied in various ways all within the spirit and scope of my invention as herein set forth and as further defined in the claims. The principle of my invention is not restricted to the parts shown, as for some purposes it may be applied to other parts—as, for instance, to the brushes.

Having described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. In a static machine, the combination with the plate, of means at the receiving-ter-

minal for preventing discharge thereat, and means at the opposite terminal for freely permitting discharge thereat.

2. In a static machine, the combination with the plate, of receiving and discharge terminals, the former being in the form of a plane electrode of considerable area substantially parallel to the plate, and the latter in the form of one or more discharge-points.

3. In a static machine comprising means for generating a static field, and electrodes for coöperating therewith, a neutralizing rod or means, having at one end an enlarged plane terminal for readily receiving electricity and reluctantly discharging the same, and at its other end terminating in means freely discharging the charge received by said plane terminal.

4. In a static machine, the combination with the plate, of a plane receiving-electrode having an extended area parallel to the surface of the plate, and a coöperating electrode having a discharge point or points next to the plate.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

THOMAS B. KINRAIDE.

Witnesses:
GEO. H. MAXWELL,
GEO. W. GREGORY.

No. 770,433. PATENTED SEPT. 20, 1904.

T. B. KINRAIDE.

THERMAL INDUCTOR.

APPLICATION FILED MAY 25, 1904.

NO MODEL.

Fig. 1.

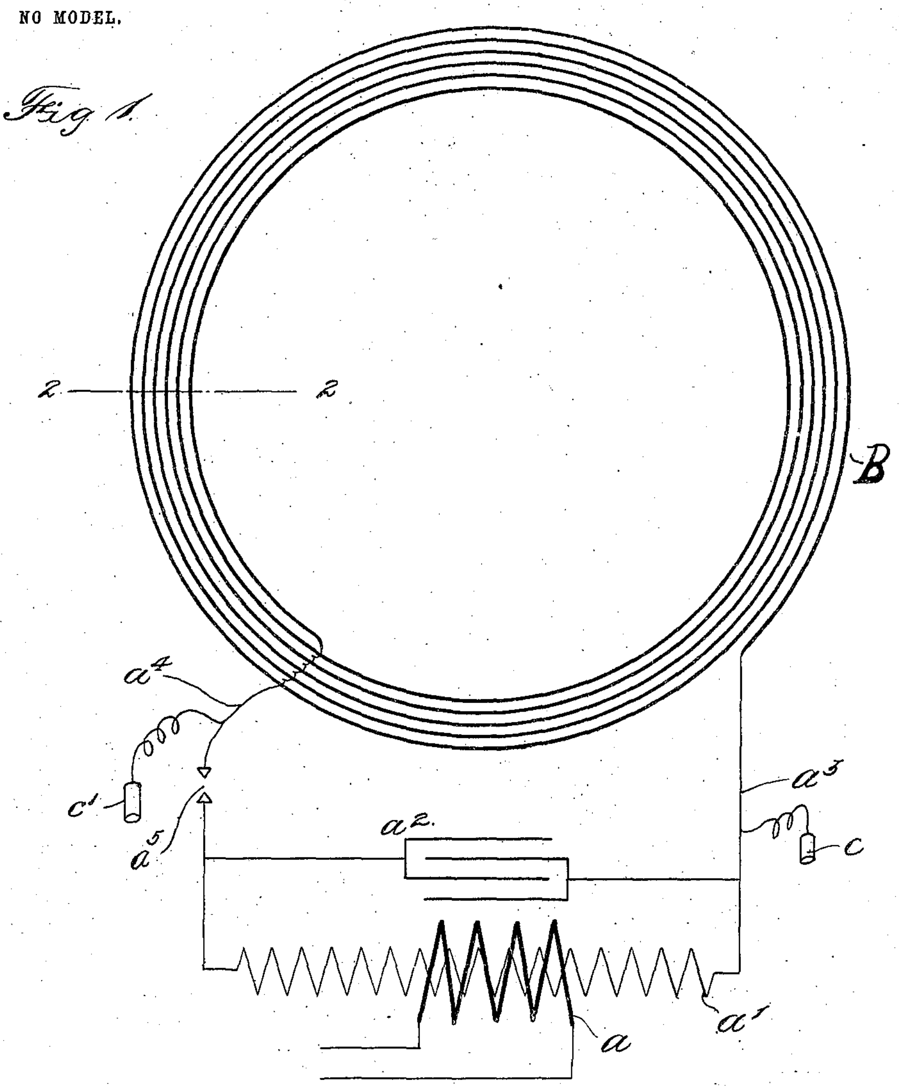
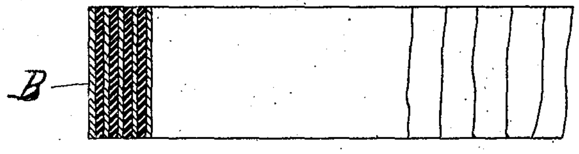


Fig. 2.



Witnesses:-

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A. M. Rice

Inventor,

Thomas B. Kinraide,

by Geo H Maxwell

Attorney.

No. 770,433. Patented September 20, 1904.

UNITED STATES PATENT OFFICE.

THOMAS B. KINRAIDE, OF BOSTON, MASSACHUSETTS.

THERMAL INDUCTOR.

SPECIFICATION forming part of Letters Patent No. 770,433, dated September 20, 1904.

Application filed May 25, 1904. Serial No. 209,687. (No model.)

To all whom it may concern:

Be it known that I, THOMAS B. KINRAIDE, a citizen of the United States, and a resident of Boston, in the Commonwealth of Massachusetts, have invented an Improvement in Thermal Inductors, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

The present invention is an electrical apparatus for therapeutical uses, the object thereof being to produce a high state of cell activity unaccompanied by the well-recognized, disagreeable, and unpleasant electrical phenomena usually attending the use of electrical apparatus.

I have discovered that it is possible to produce a peculiar heat effect, which is very advantageous in therapeutical treatment wherever sluggish conditions exist without producing any sensation of current passing through the body, but producing merely the sensation of heat. I accomplish this result by providing an electric filed of enormous frequency having very low self-inductive resistance per turn.

The structural arrangement and further advantages of my invention will be pointed out in the course of the following description, reference being had to the accompanying drawings, in which I have illustrated one embodiment of my invention.

In the drawings, Figure 1 is a diagrammatic view thereof; and Fig. 2 is a vertical cross-sectional view taken on the line 2 2, Fig. 1.

In connection with a suitable high-frequency generator, herein indicated as comprising a high-potential transformer composed of a primary a and a secondary a', the latter leading to a condenser a^2 of small area, from which lead terminals a^3 a^4, a spark-gap a^5 being interposed in one or both of said terminals, being shown in a^4, I provide a special coil B, which, taken in connection with the aforesaid high-frequency generator, produces the peculiar thermal effect, with imperceptible current effect, which constitutes my discovery. This coil B, as clearly shown in Fig. 2, in which I have shown a practical working size thereof, consists of a thin wide ribbon of suitable conducting material, such as copper, formed in a coil having large diameter and few turns. For practical purposes I have found that a coil about eighteen inches in diameter composed of five turns of ribbon one inch wide used in connection with a condenser of small capacity is very efficient for accomplishing the results which I have discovered. Suitable hand-electrodes c c' are connected to the terminals of the coil as near to the condenser as convenient, as indicated in Fig. 1.

In use the terminals c c' are grasped by the hands of the patient, or if other forms of electrodes are used they are placed upon the body or manipulated in any manner desired by the physician, the result being that a gently-permeating heat effect suffuses the portions of the body adjacent the electrodes c c' without, however, being accompanied by any of the disagreeable and in some instances dangerous electrical effects which accompany the ordinary faradic current. There is no painful spark and no danger whatever from the current, so that it can be safely applied with a sponge without any danger of bad effects in removing or applying the same in a wet condition. The enormous high frequency produced by this special coil produces a bombardment in the molecular structure of the tissues, resulting in a mechanical heat effect, and yet as the resistance per turn of the coil B is extremely low in self-induction, there being scarcely any rise in potential from turn to turn, there is no appreciable electric effect present. The high state of cell activity produced by this apparatus manifests itself in various ways—as, for example, by the production of moisture on the surface and the reddening of the skin.

I do not intend to limit myself to the precise form, proportions, or arrangement herein described, as it will be readily understood by those skilled in the art that the invention is capable of a wide variety of embodiments.

Having described my invention, what I claim to be new, and desire to secure by Letters Patent, is—

1. A device of the kind described, comprising a source of high-frequency current includ-

ing a condenser of small capacity, and a coil in series therewith, consisting of few turns of large diameter and extremely low self-inductive resistance.

2. A device of the kind described, comprising a source of high-frequency current, in series with a coil of low self-inductive resistance per turn and having an inappreciable difference in potential between successive turns.

3. A device of the kind described, comprising a high-frequency generator including a condenser of small capacity, and a coil of large diameter and few turns of conductive material presenting large superficial conducting area, said coil being connected around said condenser, and a spark-gap interposed in one terminal.

4. A device of the kind described, comprising a source of high-frequency current, in series with a coil of large diameter and few turns composed of a wide, thin ribbon conductor.

5. A device of the kind described, comprising a source of high-frequency current, in series with a coil of large diameter, few turns, and low self-inductive resistance per turn, and an electrode connected to each terminal of said coil.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

THOMAS B. KINRAIDE.

Witnesses:
Geo. H. Maxwell,
R. S. Ford.

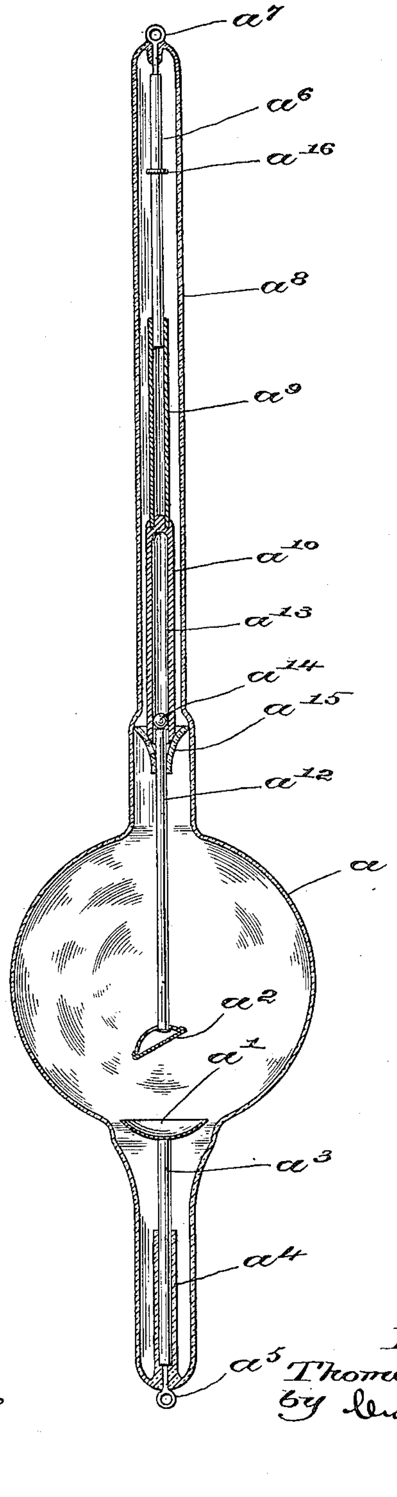
No. 659,891. Patented Oct. 16, 1900.

T. B. KINRAIDE.

ADJUSTING DEVICE FOR VACUUM TUBES.

(Application filed Dec. 26, 1899.)

(No Model.)



Witnesses.
Thomas J. Drummond.
Edward F. Allen.

Inventor.
Thomas B. Kinraide,
by Crosby Gregory Attys.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

UNITED STATES PATENT OFFICE.

THOMAS B. KINRAIDE, OF BOSTON, MASSACHUSETTS.

ADJUSTING DEVICE FOR VACUUM-TUBES.

SPECIFICATION forming part of Letters Patent No. 659,891, dated October 16, 1900.

Application filed December 26, 1899. Serial No. 741,501. (No model.)

To all whom it may concern:

Be it known that I, THOMAS B. KINRAIDE, of Boston, county of Suffolk, State of Massachusetts, have invented an Improvement in Adjusting Devices for Vacuum-Tubes, of which the following description, in connection with the accompanying drawing, is a specification, like letters on the drawing representing like parts.

This invention relates to means for adjusting or regulating the focal distance of the electrodes in vacuum-tubes such as are commonly used in X-ray work. It is quite essential that some means for accurately and delicately adjusting the electrodes in this class of instruments should be provided in order to control the voltage and otherwise regulate the proper working of the apparatus, and yet because of the vacuum requirements of the tube external adjusting means, such as might ordinarily be employed in the apparatus in general use, cannot be used, and accordingly I have provided an internal adjustment, by means of which the electrodes may be adjusted toward and from each other to the minutest degree required.

In its simplest form, as herein shown, my invention consists of a gravity-hammer or adjusting means operated by gravity.

The details of construction of my invention and its mode of operation and further advantages thereof will be pointed out more fully in the course of the following description, reference being had to the accompanying drawing, in which I have illustrated a preferred embodiment of my invention, and the latter will be more particularly defined in the appended claims.

In the drawing the figure represents in vertical longitudinal section a typical vacuum-tube provided with my improved adjusting means.

It will be understood that the tube a may be a Crookes or Geissler tube or any of the usual kinds of vacuum-tubes used for this general purpose or may be any preferred kind, and, in fact, my invention may be applied to electrical apparatus of any kind wherein electrodes are employed within a vacuum. The opposite electrodes are herein indicated at a' a^2, being such as are commonly used in connection with X-ray work, the electrode a' being supported on a conductor a^3, suitably mounted in a glass or other socket or post a^4, having an external connection by means of a suitable platinum or other wire a^5, and the electrode a^2 is similarly provided with a conductor a^6 and wire a^7, housed in a glass or other stem a^8 of the tube.

I have herein shown my improvement in connection with the electrode a^2; but it will be understood that it may be provided in connection with the opposite electrode, or, if desired, both electrodes may be made adjustable.

Slidingly mounted on the rod or conductor a^6 is a cylinder a^9, fitting said rod with sufficient exactness to prevent relative movement simply by the weight of the parts, but yet permitting the tube to slide frictionally on said rod when required, as will be more fully explained.

At its lower end, as shown, the tube a^9 carries a hollow or recessed part a^{10}, to the opposite end of which is permanently secured a rod or post a^{12}, which carries the electrode a^2. Within a longitudinal recess a^{13}, provided in the part a^{10}, I mount a gravity device, preferably in the shape of a ball a^{14}, capable of moving in said recess so as to strike projections therein, herein shown as formed by the opposite ends of the recess.

When it is desired to change the adjustment of the electrodes in any degree, all that is necessary is to move the vacuum-tube in such a manner as to cause the ball or gravity device a^{14} to strike or pound upon one or the other end of the recess a^{13}, thereby driving the cylinder a^9 onto or off from the post a^4 to the extent required.

The rod a^{12} has a bearing a^{15} in order to maintain it perfectly steady, and the rod a^6 preferably has a stop a^{16} to limit the movement in that direction of the tube or cylinder a^9.

While I have herein shown my invention in one specific and preferred embodiment thereof, I wish it understood that I am not limited thereto, inasmuch as it is capable of being embodied in very many constructions, the main idea thereof being to provide a gravity device for automatically shifting the electrode according to the position in which the vacuum-tube is placed and by this means changing the striking or focal distance of the two electrodes from each other. For instance, instead of having the part a^9 hollow to slide on the rod a^6 the parts may be reversed, and the part a^9 may slide within the part a^6, or the part a^9 or its equivalent may have frictional engagement with any other part of the conductor or tube, so as to be retarded as desired, and I may employ any kind of an electric conductor between the adjustable electrode and the external connection a^7 or a^5, as the case may be, or the gravity device, instead of being a ball sliding within a member, may encircle and slide on said member or may be in any other shape moving in or on any moving part to be adjusted, it being understood that my invention consists in its broad aspect simply in providing a gravity-operated device for overcoming the frictional resistance of the adjustable electrode.

Having described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. In a vacuum-tube having an electrode adjustable therein, means for adjusting said electrode, said means being operable by gravity, substantially as described.

2. In a vacuum-tube, an electric conductor, an electrode, connections between said conductor and said electrode including a device slidingly mounted in said tube and normally retarded frictionally from movement, and means contained within the vacuum-tube for moving said sliding device and thereby adjusting the electrode, substantially as described.

3. In a vacuum-tube, the combination with an adjustable electrode thereof, of means within the vacuum-tube and controlled by the position of said vacuum-tube for adjusting the position of said electrode, substantially as described.

4. In a vacuum-tube, an electrode slidingly mounted in the tube and having a recessed connection, and a gravity device movable in said recess for shifting the electrode in one direction or the other, substantially as described.

5. In a vacuum-tube, the combination with an electrode movably mounted therein, of a gravity-hammer for shifting said electrode, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

THOMAS B. KINRAIDE.

Witnesses:
GEO. H. MAXWELL,
GEO. W. GREGORY.